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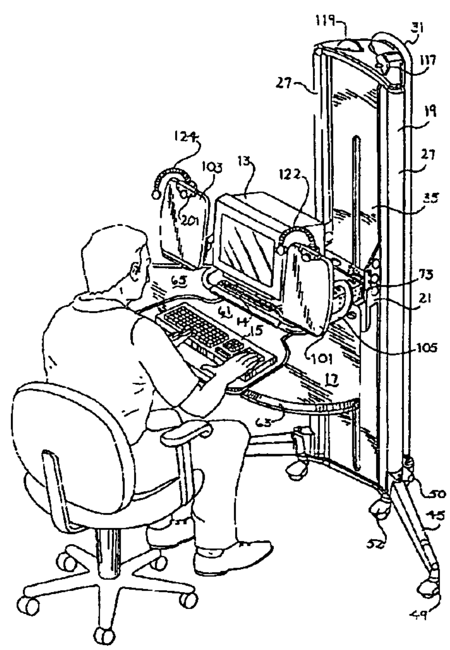
(54) POSTE DE TRAVAIL REGLABLE EN HAUTEUR
(54) HEIGHT ADJUSTABLE WORKSTATION

(57)
A workstation with a column, a height adjustment mechanism adapted to travel up and down the length of the column and to be fixed at desired positions and a brake mechanism for fixing the position of the height adjustment mechanism and which releasably engages the column, wherein the brake mechanism includes an indicator system that indicates to a user whether or not the brake mechanism is balanced.



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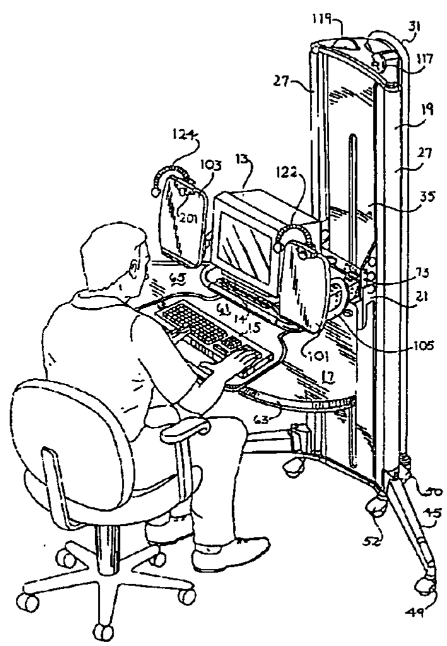


(57) Abrégé/Abstract:
A workstation with a column, a height adjustment mechanism adapted to travel up and down the length of the column and to be fixed at desired positions and a brake mechanism for fixing the position of the height adjustment mechanism and which releasably engages the column, wherein the brake mechanism includes an indicator system that indicates to a user whether or not the brake mechanism is balanced.

ABSTRACT

A workstation with a column, a height adjustment mechanism adapted to travel up and down the length of the column and to be fixed at desired positions and a brake mechanism for fixing the position of the height adjustment mechanism and which releasably engages the column, wherein the brake mechanism includes an indicator system that indicates to a user whether or not the brake mechanism is balanced.

HEIGHT ADJUSTABLE WORKSTATION

BACKGROUND OF THE INVENTION

The present invention relates to the field of office furniture and workspace systems. More particularly, the invention relates to a height adjustable workstation.

In general, a workstation provides a location for one to work at. Most often, a workstation includes at least a worksurface, typically horizontal, such as a desk or table. The workstation may also include apparatus for supporting work tools such as computers, monitors, telephones and the like.

Height adjustable workstations are known in the art. Some workstations have a range of height adjustability of a few to several inches to provide for different size users at the worksurface. Other worksurfaces have a larger range of two to three feet to allow users to make more dramatic changes, namely to accommodate working while sitting in a chair or while standing up. These latter worksurfaces are particularly advantageous in giving the user the flexibility to work in different modes.

Naturally, height adjustment mechanisms which are readily useable by the occupant of the workstation are preferable to those which require tools and skills. Such occupant useable mechanisms have, in the past, included springs, motors and/or screws to aid in raising the workstation.

Although some workstations can be moved, they are typically not considered mobile, i.e. readily movable by the user. One impediment to mobility is that most workstations cannot pass through a doorway, typically only 30 inches wide, without being disassembled. As a result, opportunities for collaboration between team members can be stymied, particularly when the collaboration would involve use of the computers and monitors of different team members.

SUMMARY OF THE INVENTION

One aspect of the present invention regards a workstation with a column, a height adjustment mechanism adapted to travel up and down the length of the column and to be fixed at desired positions and a brake mechanism for fixing the position of the height adjustment mechanism by automatically releasably engaging the vertical column based on the amount of weight supported by the height adjustment mechanism, wherein the brake mechanism includes an engagement element mounted within a bounded area that is bounded by a pair of spacers.

A second aspect of the present invention regards a workstation with a column, a height adjustment mechanism adapted to travel up and down the length of the column and to be fixed at desired positions and a brake mechanism for fixing the position of the height adjustment mechanism and which releasably engages the column, wherein the brake mechanism includes an indicator system that indicates to a user whether or not the brake mechanism is balanced.

A third aspect of the present invention regards a method of balancing a brake mechanism that fixes the position of a height adjustment mechanism adapted to travel up and down a length of a column. The method includes detecting a balancing force applied to an engagement element of the brake mechanism and that counteracts pivoting of the engagement element and indicating to a user whether the braking mechanism is balanced based on the detecting.

In accordance with one or more embodiments of the invention, the workstation has a range of height adjustability sufficient to allow a user to work sitting on the floor, sitting in a chair, and standing up, as well as any point in between. This workstation further includes a counterbalance system to facilitate manual height adjustment of the worksurface, even when heavy equipment is loaded thereon.

The preferred range of height adjustability provides the advantage that a worker is allowed to work in his most comfortable position, whether standing up, sitting in a chair, or sitting on the floor. It has been found that collaboration around a computer monitor is better facilitated by supporting the monitor at a height easily viewed while standing. Also, the near infinite height adjustability between the low and the high points allows workers of different sizes to have a worksurface at the optimum height for their size. Moreover, the preferred height adjustment mechanism which provides for easy and rapid adjustments by the user allows the user to switch between work positions without any barriers.

The collapsibility of the one or more embodiments of the invention is not only an advantage in allowing the workstation to be moved between sites within an office. It also provides advantages when shipping or storing the workstations.

It should be noted that, as used herein, the terms "horizontal" and "vertical" are not intended to be limited to strictly horizontal or vertical orientation, but rather to orientations that are at least approximately horizontal or vertical.

The present invention, together with attendant objects and advantages, will be best understood with reference to the detailed description below in connection with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a first embodiment of a workstation according to the present invention with the worksurface at chair height.

Figure 2 is a perspective view of the preferred workstation of Figure 1 with the worksurface at standing height.

Figure 3 is a perspective view of the preferred workstation of Figure 1 with the worksurface at floor height.

Figure 4 is a perspective view of the workstation of Figure 1 with the legs, side panels and display panels in the collapsed position.

Figure 5 is an exploded view of the workstation of Figure 1.

Figure 5a shows a weight element to be used with the workstation of Figure 1.

Figure 6 is a top view of the column to be used with the workstation of Figure 1 in partial cross-section.

Figure 7 is a perspective view of an embodiment of a height adjustment mechanism to be used with the workstation of Figure 1.

Figure 7a schematically illustrates an embodiment of a brake mechanism.

Figure 8 is a perspective view showing the underside of the worksurface to be used with the workstation of Figure 1.

Figure 9 is a rear perspective view of a display panel to be used with the workstation of Figure 1.

Figure 10 is an exploded view of the angle adjustment mechanism for the display panel of Figure 9.

Figure 11 is an exploded view of the preferred speed limiter.

Figure 12 is a cross-sectional view showing the inside of the speed limiter of Figure 11.

Figure 13A is a perspective view of a second embodiment of a workstation according to the present invention that is at standing height.

Figure 13B is a perspective view of the workstation of Figure 13A with the worksurface at floor height.

Figure 13C is a perspective view of the workstation of Figure 13A in a collapsed position.

Figure 14 shows an exploded view of a vertical column used with the workstation of Figures 13A-C.

Figure 15 shows a front view of the vertical column of Figure 14.

Figure 16 shows a cross-sectional view of the vertical column of Figure 13 along line 16-16 of Figure 15.

Figure 17 shows an exploded view of an attachment system for an extrusion that is used with the vertical column of Figure 14.

Figure 18 shows a side view of a brake rack used with the vertical column of Figure 14.

Figure 19 shows an exploded view of a top to be used with the vertical column of Figure 14.

Figure 20 shows an exploded view of the workstation of Figures 13A-C.

Figure 21 schematically shows a weight positioning system.

Figure 22 is an enlarged view of the circled area of Figure 21.

Figure 23 schematically shows a first embodiment of a calibration system according to the present invention.

Figure 24 shows an enlarged view of a lever used at a first position in the calibration system of Figure 23.

Figure 25 shows an enlarged view of a circled area of Figure 23.

Figure 26 shows an enlarged view of the lever of Figure 24 used at a second position in the calibration system of Figure 23.

Figure 27 shows a partially exploded view of a second embodiment of a calibration system according to the present invention.

Figure 28 shows a top perspective view of a portion of the calibration system of Figure 27.

Figure 29 shows a side perspective view of the portion of the calibration system of Figure 28.

Figure 30 shows a top perspective view of the calibration system of Figure 27.

Figure 31 shows a side perspective view of the calibration system of Figure 27.

Figure 32 shows an exploded view of the height adjustment mechanism to be used with the workstation of Figures 13A-C.

Figure 33 shows a cross-sectional view of a roller to be used with the workstation of Figures 13A-C.

Figure 34 shows an exploded view of a first embodiment of a brake mechanism to be used with the workstation of Figures 13A-C.

Figure 35 shows a side view of the brake mechanism of Figure 34.

Figures 36 and 37 schematically show the operation of the brake mechanism of Figures 34 and 35.

Figure 38 shows a top view of a worksurface to be used with the workstation of Figures 13A-C.

Figure 39 shows an exploded view of a base support for the workstation of Figures 13A-C.

Figure 40 shows an exploded view of either a leg or a support arm to be used with the workstation of Figures 13A-C.

Figure 41 shows a bottom perspective view of a male element used with the leg or support arm of Figure 40.

Figure 42 shows a top view of either the leg or support arm of Figure 40.

Figure 43 shows a side view of either the leg or support arm of Figure 40.

Figure 44A shows a bottom view of either the leg or support arm of Figure 40.

Figure 44B shows a cross-sectional view of either the leg or support arm of Figure 40 along lines 44B-44B of Figure 44A.

Figure 45 shows a bottom view of a base to be used with the workstation of Figures 13A-C.

Figure 46 shows a top view of an arm to be used with the workstation of Figures 13A-C.

Figure 47 shows a side view of the arm of Figure 46.

Figure 48 shows a perspective view of a bracket that engages the arm of Figures 46 and 47.

Figure 49 shows a perspective view of an engagement element that engages the arm of Figures 46 and 47.

FIG. 50 shows a front view of a second embodiment of a brake mechanism according to the present invention.

FIG. 51 is a front view of a comb spacer that is used with the brake mechanism of FIG. 50.

FIG. 52 is a front view of a mounting plate that is used with the brake mechanism of FIG. 50.

FIG. 53 is a front view of a brake balancer that is used with the brake mechanism of FIG. 50.

FIG. 54 shows a front view of a second embodiment of a brake mechanism according to the present invention.

FIG. 55 is a perspective view of a brake plate assembly that is used with the brake mechanism of FIG. 54.

FIG. 56 is a front view of the brake plate assembly of FIG. 55.

FIG. 57 is a perspective view of a locking plate or comb that is used with the brake mechanism of FIG. 54.

FIG. 58 is a front view of the locking plate or comb of FIG. 57.

FIG. 59 is a perspective view of a slider that is used with the brake mechanism of FIG. 54.

FIG. 60 is a top cross-sectional view of the slider of FIG. 59.

FIG. 61 is a bottom cross-sectional view of the slider of FIG. 59.

FIG. 62 is a perspective view of a slider lock that is used with the brake mechanism of FIG. 54.

FIG. 63 is a front view of the slider lock of FIG. 62.

FIG. 64 is a side cross-sectional view of the slider lock of FIG. 62.

FIG. 65 is a side view of a rod that is used with the brake mechanism of FIG. 54.

FIG. 66 shows a front view of a third embodiment of a brake mechanism according to the present invention.

FIG. 67 is a bottom perspective view of a brake plate assembly that is used with the brake mechanism of FIG. 66.

FIG. 68 is a front view of the brake plate assembly of FIG. 67.

FIG. 69 is a right end view of the brake plate assembly of FIG. 67.

FIG. 70 is a bottom end view of the brake plate assembly of FIG. 67.

FIG. 71 is a perspective view of a locking plate or comb that is used with the brake mechanism of FIG. 66.

FIG. 72 is a front view of the locking plate or comb of FIG. 71.

FIG. 73 is a perspective view of a slider that is used with the brake mechanism of FIG. 66.

FIG. 74 is a top cross-sectional view of the slider of FIG. 73.

FIG. 75 is a bottom cross-sectional view of the slider of FIG. 73.

FIG. 76 is a perspective view of a slider lock that is used with the brake mechanism of FIG. 66.

FIG. 77 is a front view of the slider lock of FIG. 76.

FIG. 78 is a side cross-sectional view of the slider lock of FIG. 76.

FIG. 79 is a bottom view of a worksurface that is attached to a visual indicator that forms part of the brake mechanism of FIG. 66.

FIG. 80 is a front view of the workstation that includes the worksurface and brake mechanism of FIGS. 66-79.

FIG. 81 is an enlarged front view of the workstation and worksurface of FIG. 80.

FIG. 82 is an enlarged view of the visual indicator of FIG. 79.

FIG. 83 is an exploded view of either a leg or a support arm to be used with the workstation of Figures 13A-C.

FIG. 84A is a bottom view of the leg or support arm of FIG. 83.

FIG. 84B is a cross-sectional view of the leg or support arm of FIG. 83 taken along line 84B-84B of FIG. 84A.

FIG. 85 is a bottom view of a base to be used with the leg of FIG. 83.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, Figures 1-3 show an embodiment of a workstation 11 with a computer monitor 13 and keyboard 15 mounted on the worksurface 17. A strap 14 is used to secure the monitor 13 to the platform 73 so that it cannot fall off when the height of the worksurface 17 is changed or when the workstation 11 is moved.

Figure 1 shows the worksurface adjusted to a height appropriate for a user sitting in a chair. Figure 2 shows the worksurface adjusted to a height appropriate for a user who is standing. Figure 3 shows the worksurface adjusted to a height appropriate for a user sitting cross-legged on the floor. Figures 2 and 3 have the front cover 35 removed to reveal the weights 127. This wide variety of height adjustment is advantageous in allowing a user to work in different position to suit the user's task and comfort. In addition, supporting a computer or other display device at a height suitable for viewing while standing is particularly advantageous in facilitating collaboration among workers.

The workstation 11 includes a vertical column 19. Preferably, the column 19 is tall enough to allow the worksurface 17 to be raised to a point as shown in Figure 2 to allow a user to work comfortably while standing. The column 19 is at least about 127 cm tall and the travel of the height adjustment mechanism is at least about 55 cm. More preferably, the column 19 is at least about 172 cm tall and the travel of the height adjustment mechanism is at least about 100 cm.

As best seen in Figures 5 and 6, the vertical column 19 is made from several parts. An aluminum extrusion 27 is included at each side of the column 19. The extrusions 27 are bolted between the base 130 and the top 120. Within each extrusion 27, a track 25 is formed.

The column 19 also includes a back panel 29 and a rear tube 31. The tube 31 includes an upside-down U-shaped portion at its top which can serve as a handle in moving the workstation. The column further includes a front panel 35 and guide tubes 33. As will be discussed below, the guide tubes guide the weight elements 127 of the counterbalance system.

The workstation 11 preferably includes legs 45 which help maintain the column 19 vertical. As depicted, the legs are preferably mounted by the bolts 47 which pass through the caps 46 and are held on the base 130. This configuration allow the legs to pivot between a use position and a collapsed position. In the use position, shown in Figures 1-3, the legs 45 are spread away from each other thereby preventing interference with the feet or chair of the user. In the collapsed position, shown in Figure 4, the legs 45 are pivoted toward each other to allow the workstation to pass through a doorway, preferably a 30 inch doorway.

Preferably, the legs 45 and the column 19 include rollers 49, 50 and 52 so that the workstation can be readily moved along a floor. Most preferably, the rollers 49, 50 and 52 are omni-directional castors such as shown in the figures. Alternatively, the rollers can be wheels. At least some of the rollers are equipped with a conventional brake. Naturally, the rollers should be able to roll over various types of floors and minor obstacles.

The workstation also includes a height adjustment mechanism. In the depicted embodiment, this mechanism consists of a car 21 (see also Figures 5-7). The car 21 includes four rollers 23, two on each side. These rollers 23 are adapted to ride within the tracks 25 in the aluminum extrusions 27 on both sides of the column 19.

The car 21 preferably includes a brake mechanism to releasably fix the worksurface 17 at different heights along the column 19. The brake is shown in Figures 7 and 7a. A vertical rack 37 is attached to the column 19. An engagement element 39 includes teeth that mesh with the teeth of the rack 37. The element 39 is mounted to a block 41 that is biased by spring 43 toward the rack 37, thus locking the height of the car 21 along the column 19. To release the brake and adjust the height of the worksurface, the block 41 with the engagement element 39 is pulled back from the rack 37, for example by a lever actuated cable (not shown).

Alternative brake mechanisms can also be used. For example, a simple clamping device mounted to the car which clamps on a feature of the column could be used. Also, a series of holes or detents can be provided on the column with which a pin or other feature on the car indexes. The brake mechanism of FIGS. 34-37 and described below can be used as well.

The car 21 also includes a speed limiter 230 to prevent the worksurface from changing height too rapidly. In particular, it is desired to prevent the worksurface from falling down when the brake is disengaged, especially when heavy equipment is mounted on the worksurface. Moreover, as will be described in detail below, the workstation preferably includes a counterbalance system to assist in lifting the worksurface, particularly with heavy equipment mounted thereon. Thus, it is also desirable to prevent the worksurface from rising too rapidly, for example if the counterbalance is adjusted for more weight than is placed on the worksurface.

The preferred form of the speed limiter is shown schematically in Figure 11. The limiter includes fits on the left side of the car 21 in a semicircular cutout 231. An outer gear 233 is held in place so that its teeth mesh with the rack 37. The outer gear 233 rotates on an inner wheel 235. The inner wheel 235 includes two ears 237 that are attached to the car 21 so that the wheel 235 is not allowed to rotate. Disposed within and rotating with the outer gear 233 are two

pawls 241 and 243. Each pawl pivots on the central journal 244. The pawl 241 is biased by spring 245 and the pawl 243 is biased by spring 247 so as to bring the ends away from the teeth 236 of the inner wheel 235. Nonetheless, as the angular speed of the gear 233 increases, centripetal force acts against the springs and the ends of the pawls are swung out into contact with the teeth 236, thus stopping rotation of the gear 233 and stopping the travel of the car 21. Preferably, the brake 230 is configured to prevent the worksurface from moving faster than about 4 feet per second up or down.

Attached to the car 21 is a bracket 35 that supports the worksurface 17. Specifically, the bracket 35 includes a bottom plate 68 and flanges 69 that cooperate to support the center section 61 of the worksurface. Specifically, the arrangement is designed so that the center section 61 can slide in the bracket to thereby allow the user to adjust the depth of the section 61.

The bracket 35 is configured to support an elevated platform 73 on top of the bracket (see Figure 7). The platform 73 is configured so as to be adjustable in height and depth. As depicted, this is most preferably accomplished by providing a series of front holes 76 and back holes 74 in the platform 73. Bolts or pins are inserted through the front holes 36 on the bracket 35 and one of the front holes 76 in the platform 73. Likewise, bolts or pins are inserted through the rear holes 34 and one of the rear holes 74 in the platform 73. In this way, the height depth, and even the angle of the platform 73 can be adjusted relative to the rest of the worksurface 17.

As shown in Figures 1-3, this platform preferably supports a computer monitor. Alternatively, the platform can be made large enough to hold two or more computer monitors. Straps 14 are preferably included to secure the monitors or other equipment to the platform 73.

The bracket 35 also includes two hinges 71. Attached to the hinges 71 are the right side 63 and left side 65 of the worksurface 17. As a result, the sides 63 and 65 can be moved between a horizontal position (see Figures 1-3)

to a collapsed or vertical position (see Figure 4), thereby allowing the workstation to be more easily passed through a doorway. As depicted in Figure 4, it is preferred to fold the sides 63 and 65 down. Alternatively, the sides can be folded up. Still alternatively, the sides can be made to pivot horizontally so as to pivot into a retracted position. Also, the sides can be made to be easily detached and reattached so as to provide the collapsibility for the workstation to pass through doorways.

The perspective view of Figure 8 from beneath the worksurface 17 shows a method of supporting the sides 63 and 65. In particular, pivoting arms 81 and 83 are provided to support the sides 63 and 65, respectively. Retainer clips 85 and 87 are mounted to the bottom of the sides 63 and 65 to hold the arms 81 and 83 in place. To fold down the sides 63 and 65, the arms 85 and 87 are released from the clips 85 and 87 and pivoted toward each other so as to be beneath the center section 61. Support plates 89 and 91 are attached to the sides 63 and 65. These plates serve to support the center section 61, particular as it slides in and out of the bracket 35.

The workstation also includes display panels 101 and 103 which are supported above the worksurface 17 and are adapted to move up and down with the worksurface. These panels 101 and 103 are preferably equipped with clips 201 or the like to hold papers or other objects for the workstation user. The display panels are supported on bent bars 105 and 107. Most preferably, the display panels are pivotably attached to the bars so as to be adjustable between a vertical position and a horizontal position, and to be adjustable between a use position (see Figures 1-3) and a collapsed position (see Figure 4). As shown in Figure 10, this is preferably accomplished with a pivotable adjustment knuckle 104 which includes a series of turn and non-turn washers 211, 213, 217, 219, and 221 which work with the end place 209, the knuckle body 215 and the adjustment screw 223 to provide the adjustment and locking of the display panel in the desired orientation.

The workstation also includes lights 122 and 124 mounted so as to move up and down with the worksurface 17. Preferably, these lights are mounted to the display panels 101 ad 103. Still other equipment for the user may also be mounted to the workstation, such as a telephone or audio speakers.

While the monitor 13 is preferably mounted on the platform 73 and the keyboard 15 is preferably supported on the center section 61 of the worksurface 17, the CPU for a computer may be mounted on various locations. For example, the CPU may rest on the platform 73 and under the monitor 13. Alternatively, the CPU may be mounted to the underside of the worksurface or on a shelf or ledge attached to the side of the column 19. Otherwise, the CPU may be supported on a separate stand or dolly.

The workstation includes a counterbalance mechanism so that raising the worksurface 17 manually is not difficult, even when heavy equipment, such as a 21 inch monitor, is mounted thereon. The preferred counterbalance mechanism includes weights, a cable and pulleys. Specifically, a cable 115 is attached at one end to the car 21 on the top right side 111 and attached at the other end to the car on the top left side 113. This cable passes over the top pulleys 117 and 119 and under the weight pulley 121. Consequently, as the worksurface is lowered, the weight pulley is raised and vice versa.

The weight pulley 121 is attached to the bar 123 which includes a column of holes 125. A plurality of weight elements 127 and 128 are provided with a hole 126 in the middle through which the bar 123 passes (See Figure 5a). The weight elements are shaped to slide within the column. Specifically, a semicircular groove 128 is provided on both sides of each weight element 127. The guide tubes 33 are configured to fit within these grooves 128. Most preferably a bushing is included within the groove 128 to reduce friction.

Each weight element 127 also includes a groove 132 to receive the pin 129. Specifically, the pin 129 is inserted through one of the holes 125 in the bar 123 so as to select how many of the weight elements are lifted when the bar

123 is raised. In this way, the amount of weight applied by the counterbalance can be easily adjusted by the user. A rubber pad 128 is preferably placed on the base 130 so that the weight elements 127 contact the pad 128 when fully lowered.

The counterbalance system includes twenty weight elements 127, each of which weighs about 7.5 pounds. Some of the weight elements, most preferably eight, are permanently fixed to the bar 123 so that the cable is in constant tension, even when the pin 129 is removed from the bar.

Alternative counterbalance systems may also be used. For example, water filled weights can be used and adjusted by the amount of water used. Also, an adjustable compression or tension spring system may be used.

While the height adjustment mechanism is manually actuated, it can also be motorized by conventional means such as a rotated screw or chain drive.

A second embodiment for a workstation is shown in FIGS. 13-47. As shown in FIGS. 13-15, the workstation 300 includes a vertical structure such as the vertical column 302 that is attached to a base 304 and a top 306. The vertical column 302 acts as a support for a pair of vertical tracks 308 and a pair of braking racks 310. As shown in FIGS. 14-17, each of the vertical tracks 308 is formed from an aluminum extrusion 312 that is bolted to the base 304 and the top 306. The lower portion of each extrusion 312 is attached to the top of the base 304 via three screws or nut and bolts (not shown). As shown in FIG. 17, an inverted L-shaped attachment piece 314 is attached to the lower portion of the extrusion 312 by a plate 316 that has a pair of openings 318 that are aligned with corresponding openings of the extrusion 312 and the attachment piece 314 so that a pair of screws 319 (the screw for the extrusion 312 is not shown) are inserted into the aligned openings. Each extrusion 312 is attached to the top 306 via three screws or nuts and bolts 320.

As shown in FIGS. 14-16, the extrusions 312 act as a frame for attaching the back panel 322 thereto. In particular, the back panel 322 has a plurality of openings 324 that align with corresponding openings in the extrusions 312 so that screws can be inserted therethrough. Prior to insertion of the screws, a pair of vertical racks 310 have their openings 326 aligned with the aligned openings of the extrusions 312 and the back panel 322 so that the screws attach all three elements together.

To provide further structural support for the workstation 300 and the vertical column 302, a pair of tubes 330 are attached to and extend between the base 304 and the top 306. The free upper end of each tube 330 is threadedly inserted into a threaded opening formed in a corresponding extension 336. Similarly, the free lower end of each tube 330 is threadedly inserted into a threaded opening 338 formed in the rear portion of the base 304. Foam tubes 334 are inserted over the op portions of the tubes 330 so that the tubes 334 and the upper portions of the tubes 330 can be used as handles to move the workstation 300 from one place to another.

Within the vertical column 302, a position adjustment mechanism is mounted for moving an object, such as a worksurface 336, from a first vertical position to a second vertical position. The position adjustment mechanism preferably is a weight counterbalance system 339. As shown in FIGS. 13-15 and 19-20, the weight counterbalance system 339, includes a pair of pulleys 340, 342 rotatably supported on the top 306 by a pair of axles 500 that have two ends supported in a slot 502 and a center section supported by a bearing 504 located within the pulley. The pulleys are hidden by plastic covers or caps 506 that have tabs 508 that engage the walls of the slot 502. The left pulley 340 supports a cable 344 that has one free end attached to an pin inserted through the opening 346 located at the left of the rear portion of the car 348 while the other free end of the cable 344 is attached to the left pin 350 of the bar bracket 352. The right pulley 342 supports a second cable 344 that has one free end attached to a pin

inserted through an opening 346 located at the right of the rear portion of the car 348 while the other free end is attached to the right pin 350 of the bar bracket 352. Note that the free ends of the cables 344 preferably have tear drop shaped washers (not shown) attached thereto so as to provide an opening to engage the pins described above. As shown in FIGS. 27-29, the bar bracket 352 is attached to a vertical bar 360 that has one or more holes 362 that are used to support one or more weights 364.

Like the weight elements 127 and 128 of FIGS. 1-12, the weights 364 are provided with a hole 365 in the middle through which the bar 360 passes so as to be adjacent to the weight elements. The weight elements 364 are shaped to slide within the column. Specifically, a groove 367 is provided on both sides of each weight element 364. The free ends 329 of the racks 310 are configured to fit within these grooves 367. Most preferably a plastic bushing 328 is included within the groove 367 to reduce friction. One or more rubber pads 369 are preferably placed on the base 304 so that the weight elements 364 contact the pad(s) 369 when fully lowered.

The counterbalance system includes a plurality of weight elements 364, each of which weighs about 7.3 pounds. The total number of weight elements 364 is equal to the number to counterbalance the maximum weight of equipment that is anticipated to be placed on the worksurface 336. Accordingly, as many as twenty weight elements 364 may be used in the counterbalance system. Some of the weight elements may be permanently fixed to the bar 360 so that the cable 344 is in constant tension, even when the pin 368 is removed from the bar 360.

To understand the problems encountered by a number of weight counterbalance systems in general, the reader's attention is directed to FIGS. 21 and 22 which schematically show how a typical weight counterbalance system would act on the worksurface 336, bar 360 and weights 364 of the present invention. In such a system, the bar 360 is biased upward due to the front load

generated by the worksurface 336 and the objects 413, 429 thereon and the weights 364 are biased downward due to gravity. The opposing biases may create a misalignment between the holes of the bar 360 and the weights 364 and may create a shear force on the pin 368 so as to make it difficult to remove and replace.

As schematically shown in FIGS. 23-26, the present invention counteracts the above described disadvantage by using a calibrator, such as a cam mechanism like the cammed lever 366, to adjust the length of the cable 344 so as to calibrate the position of a weight so that the weight can be attached to the weight counterbalance system. The lever 366 provides the additional advantage that it acts as a safety device by reducing the possibility of the pin 368 being removed when the weights 364 are not in their lowest position and prevents unintentional removal of the pin 368 by hiding the pin 368 when it is at its rest position.

In operation, the user first determines the number n weights 364 that are to be supported on the bar 360 for easily moving the worksurface 336 and any objects thereon. The user then lifts the lever 366 upward so as to reveal the holes 362 initially hidden by the lever 366. The user then determines whether or not a hole 362 associated with the nth weight as counted from top is obstructed by the nth weight. If the associated hole is determined to be obstructed by the nth weight, then the cammed lever 366 is pivoted from a vertical direction upward causing the bar 360 to move downward relative to the weights 364. Pivoting of the lever 366 is discontinued when the hole associated with the nth weight is unobstructed. At this point, a pin 368 is inserted into the unobstructed hole associated with the nth weight so that a groove 370 of the nth weight 364 rests on the pin 368.

As schematically shown in FIGS. 23-26, one embodiment of the present invention has the cable 344 attached at a point A of a cammed portion

372 of the lever 366. The cammed portion 372 has an arcuate slot 374 that receives a pin 376 attached to the top of the bar 360. Rotation of the lever 366 upward increases the distance from point A to the pin 376 and, thus, lowers the bar 360 relative to point A. Rotation of the lever 366 acts in effect as if the cable 344 has been lengthened.

Another embodiment of the present invention that allows for the bar 360 to be calibrated and moved relative to the weights 364 is shown in FIGS. 20 and 27-29. The embodiment of FIGS. 20 and 27-29 differs from that of FIGS. 1-12 in that the two cables 344 passing over the pulleys 340 and 342 are attached to the left and right cable pins 350 of the bracket 352. The bracket 352 is made of a pair of parallel plates 384 between which an inverted T-shaped preload bracket 386 is inserted and attached thereto by a central pin 388. The pins 350 are able to pivot about pin 388 in order to compensate for those instances when one of the two cables 344 is longer than the other.

The bracket 386 has a pair of ears 389 that have openings 390 to receive a pin 392 with its bushing 394. The pin 392 and bushing 394 are inserted through an opening 374 in the cammed lever 366 prior to being attached to the ears 389. Once assembled, the lever 366 is able to pivot about the pin 392.

Like the cammed lever 366 of FIGS. 24 and 26, the cammed lever 366 of FIGS. 27-31 has a cammed portion 372 with an arcuate slot 374. The slot 374 cooperates with a constraining pin 398 and its bushing 400 that are inserted through openings 402 formed in a pair of ears 404 integrally formed with the bar 360.

The bar 360 is slidingly attached to the bracket 386 by inserting a pair of pins 512 through corresponding oblong holes 406 formed in the top of the bar 360 and circular holes 513 formed in the bracket 386. The holes 406 each has a length that allows the pins 512 to move a distance of approximately 3/8" while in the holes 406.

As shown in FIGS. 20 and 27-31, the brackets 382, 386 and the lever 366 are housed between two preload weights 408 and 410 that are attached to one another by a pair of bolts 412 that are inserted into openings formed the front preload weight 408, openings 414 formed in the bracket 386 and threaded openings formed in the rear preload weight 410.

Operation of the calibration system of FIGS. 20 and 27-31, is similar to that described above with respect to the calibration system of FIGS. 21 and 22. One difference is the use of the preload weights 408 and 410. It is anticipated that when the workstation 300 is initially unloaded from its packaging, the bar 360 will not be attached to any of the weights 364. This would cause an imbalance if the preload weights 408 and 410 were absent in that there would be a load at one end of the cables 344 produced by the worksurface 336 and its moving assembly while no counterbalancing load would be present at the other ends of the cables 344. The preload weights 408 and 410 solve this by being permanently attached to the other ends of the cables 344 and having a combined weight of approximately 30 pounds that counterbalances the load generated by the worksurface and its moving assembly. If the total weight of the preload weights 408 and 410 is below the amount needed to counterbalance the load, then one or more of the weights 364 can be permanently attached to the bar 360 so as to provide the extra weight needed to counterbalance the load.

After the workstation 300 has been positioned, the user determines the number n weights 364 that are to be supported on the bar 360 for easily moving the worksurface 336 and any objects 413 thereon. The user then removes the lower front cover 510 so as to uncover the holes 362 and determine whether or not a hole 362 associated with the nth weight as counted from top is obstructed by the nth weight. If the associated hole is determined to be obstructed by the nth weight, then a finger pull 514 pivotably attached to the lever 366 is grabbed so that the cammed lever 366 is pivoted from a vertical direction upward. Upward pivoting causes the bar 360 to move downward relative to the

weights 364. The bar 360 moves downward since rotation of the slot constrains the pin to move downward. Since the pin 398 is indirectly attached to the cables 344, the downward movement of the pin 398 and the bar 360 is allowed because the lengths of the cables 344 are lengthened by the upward movement of the lever 366. Pivoting of the lever 366 is discontinued when the hole associated with the nth weight is unobstructed. At this point, a pin 368 is inserted into the unobstructed hole associated with the nth weight so that a groove 370 of the nth weight 364 rests on the pin 368.

Note that the lower front cover 510 is made of plastic and has a plurality of vertical tabs on each side that engage slots 511 formed in the brake rack 310 (see FIG. 18). The top edge of the lower front cover 510 has an indentation to receive a lower edge of a top front cover 513. The top front cover 513 has vertical tabs like the lower front cover 510 that engage upper slots 511 of the brake rack 310. In another embodiment, the front cover can be made of one piece where a lower slot 508 is formed so as to allow the lever 366 to be pivoted therethrough.

Once the pin 368 has been inserted into the unobstructed hole, the lever 366 is pivoted to the vertical position shown in FIGS. 20, 28 and 29 so as to unobtrusively store the lever 366 in front grooves 371 formed in the weights 364 and allow the lower front cover 510 to be reattached. The user then grabs the worksurface 336 and moves it to a desired vertical position so that as the worksurface 336 is lowered, the bar 360 and the attached weight elements are raised and vice versa. As with the workstation of FIGS. 1-12, the workstation 300 provides infinite vertical height adjustability that provides the advantage that a worker is allowed to work in his most comfortable position, whether standing up, sitting in a chair, or sitting on the floor. Preferably, the column 302 is tall enough to allow the worksurface 336 to be raised to a point like shown in Figure 2 to allow a user to work comfortably while standing. Preferably, the column 302 is at least about 127 cm tall and the travel of the height adjustment mechanism is

at least about 55 cm. More preferably, the column 302 is at least about 172 cm tall and the travel of the height adjustment mechanism is at least about 100 cm. Note that while the height adjustment mechanism is manually actuated, it can also be motorized by conventional means such as a rotated screw or chain drive.

Note that alternative counterbalance systems may also be used. For example, the cable can be attached directly to the weight elements instead of indirectly as described above. In another example, water filled weights can be used and adjusted by the amount of water used. Also, an adjustable compression or tension spring system may be used.

The worksurface 336 is moved vertically by a height adjustment mechanism that is similar to that used for the worksurface of FIGS. 1-12. In particular, the height adjustment mechanism of FIGS. 13, 20 and 32 includes a die-cast aluminum car 400 that has the same dimensions as the car 21 of the workstation of FIGS. 1-12. Like car 21, the car 348 includes four rollers 402, two on each side that are rotatively attached to the car 348 via axle 516, ball bearing 518 and ring 520 in a well known manner. Each of the rollers 402 is adapted to ride within and along the tracks 308 of the extrusions 312. As shown in FIGS. 32 and 33, each of the rollers 402 has a center opening and has a diamond-like shape so as to improve centering of the rollers 402 in the tracks 308. The rollers are preferably made of a hard plastic material.

The car 348 preferably includes a brake mechanism to releasably fix the worksurface 336 at different heights along the column 302. The preferred form of the brake mechanism is shown in FIGS. 32 and 34-35. In particular, the braking mechanism includes the pair of vertical racks 310 having equally spaced rectangular slots 404 (see FIG. 18). The brake mechanism further includes a pair of engagement elements 406 that are mounted within recesses of corresponding blocks 408 attached to opposite sides of the car 348 via bolts (not shown) inserted through openings 409 of the car 348 and openings 411 of the block 408. Each of the engagement elements 406 includes one or more male

engagement members 417 that are biased by a spring 410 toward the slots 404 so that each member 417 is inserted into a slot 404. One end of the spring 410 is attached to the edges of an opening 602 of the engagement element 406 while the other end of the spring is attached to the edges of the opening 604 of the blocks 408. When the members 417 are inserted into the slots 404, the car 348 is locked at a certain height along the column 302. At the locked position, a pair of ears 606 of the engagement element 406 engage the edges 608 of recesses 610 formed in the block 408. The ears 606 and recesses 610 may be parallel with one another (FIG. 34) or offset from one another (FIG. 35).

To release the brake mechanism and adjust the height of the worksurface 336, the male engagement members 417 are pulled back from the slots 404 by lever actuated cables 415 associated with the engagement elements 406. One end of a cable 415 is inserted through an opening 612 in the block 408 and is attached to the edges of the opening 614 of the engagement element 406. The cables 415 are controlled in a well known manner by corresponding paddles (not shown) mounted on the bottom of the central section 418.

Alternative brake mechanisms can also be used. For example, the braking mechanisms of FIGS. 7 and 7a can be used to replace each of the braking mechanisms of FIGS. 34-37. Another possibility is to use the braking mechanism in combination with the speed limiter 230 described previously in order to prevent the worksurface from changing height too rapidly.

Another possibility for a brake mechanism is shown in FIGS. 50-53. The brake mechanism is similar to the one described above with respect to FIGS. 34-37 in that the brake mechanism 700 has one or more engagement elements 702 that have one or more male members 704 that selectively engage the rectangular slots 404 of the vertical racks 310. As shown in FIG. 50, an engagement element 702 is mounted within an area 706 bounded by a pair of comb spacers 708 (FIG. 51) welded to a mounting plate 710 (FIG. 52). The comb spacers 708 have openings 711 that are aligned with corresponding

openings 713 of the mounting plate 710. Bolts are inserted into the aligned openings 711 and 713 so as to attach the braking mechanism 700 to the car 348 in a manner similar to the attachment of the braking mechanism of FIGS. 34-37 with the car 348.

The engagement element 702 has a pair of ears 712 that are inserted into recesses 714 of the area 706. The ears 712 and the recesses 714 control the translational movement of the engagement element 702 in a manner similar to the ears 606 and recesses 610 of the brake mechanism of FIGS. 34-37. Besides controlling translational movement, the brake mechanism 700 controls the pivotal motion of the engagement element 702 by means of a recess 716 formed in the engagement element 702 and a pair of brake balancers 718 (lower brake balancer not shown) that are mirror images of one another (FIG. 53). As shown in FIG. 50, the brake balancers 718 are pivotally attached to the mounting plate 710 via a pin 720 and a spring 722 attached at point A of the brake balancer 718 and point B of the mounting plate 710. The ears 712 have a length of approximately 0.125 inches and the recesses 714 have a length of approximately 0.63 inches and a depth of approximately 0.226 inches. The recess 716 has a length of approximately 0.51 inches and a depth of approximately 0.05 inches. The spring 722 has a natural length of approximately one inch and a spring constant of approximately 17 pounds per inch.

In operation, when the male members 704 are inserted within the slots 404 and the front load on the worksurface 336 is greater than the load of the weights 364, the car 348 will tend to move downward. The downward movement causes the engagement element 702 to pivot upward about the upper protuberance 724 so that the male members 704 are unbalanced in that they are no longer centered within the slots 404. Pivoting of the engagement element 702 causes the engagement element 702 to push up against the surface 726 of the brake balancer 718 that resists the upward push via spring 722. Thus, if the difference in the front load and the weights 364 is not too great (less than 17

pounds), then the spring 722 prevents the recess 716 from rising a sufficient distance to have the surface 728 of the upper comb spacer 708 inserted within the recess 716. In such a case, the male members 704 can be removed from the slots 404 via the lever actuated cables 415 and paddles even though the engagement element 702 is unbalanced. In the case that the front load outweigh the weights 364 by more than 17 pounds, then the rate force on the engagement element 702 overcomes the downward bias of the spring 722 and the surface 728 enters the recess 716. Thus, the engagement element 702 and the male members 704 are prevented from being removed from the slots 404.

In the case that the weights 364 outweigh the front load on the worksurface 336, then the engagement element 702 is pivoted downwards about the lower protuberance 730 so that the lower brake balancer 718 acts on the engagement element 702 in the same manner that the upper brake balancer 718 operates as described above.

Another possibility for a brake mechanism is shown in FIGS. 54-65. The brake mechanism is similar to the one described above with respect to FIGS. 50-53 in that the brake mechanism 900 has one or more engagement elements 902 that have one or more male members 904 that selectively engage the rectangular slots 404 of the vertical racks 310. As shown in FIG. 54, an engagement element 902 is mounted within an area 906 bounded by a pair of vertical comb spacers 908 (FIGS. 54-56) integrally formed with mounting plate 910. The mounting plate 910 has openings 911 that are aligned with corresponding openings of the car 348. Bolts or standoffs 915 are inserted into the aligned openings so as to attach the braking mechanism 900 to the car 348 in a manner similar to the attachment of the braking mechanism of FIGS. 50-53 with the car 348.

As shown in FIGS. 54, 57 and 58, the engagement element 902 has a pair of rearward ears 912 that have a length of approximately 0.43 inches

and jut away from the sides 917 of the engagement element 902 by approximately 0.125 inches.

The ears 912 and the vertical comb spacers 908 control the translational movement of the engagement element 902 as will be described below. In addition, the brake mechanism 900 controls the pivotal motion of the engagement element 902 via a pair of brake balancers, such as springs 918 and sliders 931, that are identical to one another and are mirror images of one another (FIG. 54). As shown in FIGS. 54 and 65, a pair of rods 919 are inserted into holes 921 formed in the mounting plate 910 where an outer end 923 of the rod 910 is attached to a vertical flange 925 that is integrally formed from the mounting plate 910. The springs 918 encircle the rods 919 as shown in FIG. 54.

As shown in FIGS. 54 and 65, an inner end 927 of each rod 919 flares radially outward from the main body of the rod so as to act as a stop with respect to movement of a slider 931. As shown in FIGS. 54 and 59-61, an end portion of each spring 918 extends into a channel 929 and is attached to a post 930 formed in a respective slider 931. The springs 919 engage the sliders 931 and compressively engage the sliders 931 so that the sliders 931 are moved toward and engage the sides 917 of the engagement element 902.

Besides being biased by the sliders 931, the engagement element 902 is biased toward the vertical racks 310 by a spring 939 that has one end attached to notch 941 of the engagement element 902 and another end attached to the hole 943 formed in the mounting plate 910.

The rearward motion of the engagement element 902 is inhibited by a slider lock 945 that is shown in FIGS. 54 and 62-64. The slider lock 945 has a rectangular guide 947 that is inserted into and permanently attached to a slot 949 formed in the mounting plate 910. The slider lock 945 has a vertical post 950 that is inserted within a triangular-like opening 952 formed in the engagement element 902 so that the rear end 954 of the engagement element 902 lies

between the post 950 and the stop surface 956 of the slider lock 945 as shown in FIGS. 54 and 57-58.

In operation, when the male members 904 are inserted within the slots 404 and the front load on the worksurface 336 is greater than the load of the weights 364, the car 348 will tend to move downward. The downward movement causes the engagement element 902 to pivot upward so that the male members 904 are unbalanced in that they are no longer centered within the slots 404. Pivoting of the engagement element 902 causes the engagement element 902 to push up against the surface of the upper slider 931 that resists the upward push via its corresponding spring 918. Thus, if the difference in the front load and the weights 364 is not too great, then the spring 918 prevents the engagement element from rising a sufficient distance so that the ears 912 of the engagement element 902 can pass between the area 906 bounded by the pair of vertical comb spacers 908. In such a case, the male members 904 can be removed from the slots 404 via the lever actuated cables 415 and paddles even though the engagement element 902 is unbalanced. In the case that the front load outweighs the weights 364 by more than 17 pounds, then the force on the engagement element 902 overcomes the downward bias of the spring 918 and the ears 912 of the engagement element 902 cannot pass between the comb spacers 908. Thus, the engagement element 902 and the male members 904 are prevented from being removed from the slots 404.

In the case that the weights 364 outweigh the front load on the worksurface 336, then the engagement element 902 is pivoted downwards so that the lower spring 918 and slider 931 act on the engagement element 902 in the same manner that the upper spring and slider operate on the engagement element 902 as described above.

Note that the slider lock 945 limits the translation motion of the engagement element 902. For example, when the cables 415 are not actuated, the engagement element 902 is pushed toward the rack 310 by the spring 939.

Since the slider lock's post 950 is within the opening 952, movement of the engagement element 902 toward the rack 310 continues until the post 950 engages the rear side of the opening 952. Similarly, when the cables 415 are actuated, movement of the engagement element 902 away from the rack 310 continues until the post 950 engages the front end of the opening 952.

Yet another possibility for a brake mechanism is shown in FIGS. 66-82. The brake mechanism is similar to the one described above with respect to FIGS. 54-65 in that the brake mechanism 900 has one or more engagement elements 902 that have one or more male members 904 that selectively engage the rectangular slots 404 of the vertical racks 310. One difference with the brake mechanism of FIGS. 54-65 is that the brake mechanism of FIGS. 66-82 does not use the pair of vertical comb spacers 908 (see FIGS. 54-56) integrally formed with mounting plate 910.

The mounting plate 910 of the braking mechanism of FIGS. 66-82 has openings 911 that are aligned with corresponding openings of the car 348. Bolts or standoffs (not shown) are inserted into the aligned openings so as to attach the braking mechanism 900 to the car 348 in a manner similar to the attachment of the braking mechanism of FIGS. 54-65 with the car 348.

As shown in FIGS. 66, 71 and 72, the engagement element 902 has a pair of rearward ears 912 that have a length of approximately 0.43 inches and jut away from the sides 917 of the engagement element 902 by approximately 0.143 inches.

The brake mechanism 900 controls the pivotal and translational motion of the engagement element 902 via a pair of brake balancers, such as springs 918 and sliders 931, that are identical to one another and are mirror images of one another (FIG. 66). As shown in FIG. 66, a pair of rods 919 are inserted into holes 921 formed in the mounting plate 910 where an outer end 923 of the rod 910 is welded to a vertical flange 925 that is integrally formed from the mounting plate 910. The springs 918 encircle the rods 919 as shown in FIG. 66.

As shown in FIG. 66, an end portion of each spring 918 extends into a channel 929 and is attached to a post 930 formed in a respective slider 931. The springs 919 engage the sliders 931 and compressively engage the sliders 931 so that the sliders 931 are moved toward and engage the sides 917 of the engagement element 902.

Besides being biased by the sliders 931, the engagement element 902 is biased toward the vertical racks 310 by a spring 939 that has one end attached to notch 941 of the engagement element 902 and another end attached to the mounting plate 910.

The rearward motion of the engagement element 902 is inhibited by a slider lock 945 that is shown in FIGS. 66 and 76-78. The slider lock 945 has a rectangular guide 947 that is inserted into and permanently attached to a slot 949 formed in the mounting plate 910. The slider lock 945 has a vertical post 950 that is inserted within a rectangular-like opening 952 formed in the engagement element 902 so that the rear end 954 of the engagement element 902 lies between the post 950 and the stop surface 956 of the slider lock 945 as shown in FIGS. 66 and 71-72.

In operation, when the male members 904 are inserted within the slots 404 and the front load on the worksurface 336 is greater than the load of the weights 364, the car 348 will tend to move downward. The downward movement causes the engagement element 902 to pivot upward so that the male members 904 are unbalanced in that they are no longer centered within the slots 404. Pivoting of the engagement element 902 causes the engagement element 902 to push up against the surface of the upper slider 931 that resists the upward push via its corresponding spring 918.

A visual indicator system 1000 is used to inform the user of the workstation whether or not the male members are unbalanced. As shown in FIGS. 66 and 79-82, the visual indicator system 1000 includes a cable 1002 attached to one of the sliders 931 and that is attached to the underside of the

worksurface 336 as shown in FIG. 79. The other end of the cable 1002 is inserted into an indicator housing 1004 and is attached to a visual indicator 1006, such as a black colored annular piece 1008. As shown in FIG. 82, the annular piece 1008 is unattached to any other elements other than the cable 1002.

The annular piece 1008 is visible to the user via a clear plastic window 1010 that has three colored zones 1012, 1014 and 1016 as schematically shown in FIG. 82. In the embodiment of FIG. 82, the colored zones 1012 and 1016 are preferably red in color and each have an equal length. The colored zone 1014 is preferably green in color and lies between colored zones 1012 and 1016.

In a second embodiment of the window 1010, the green colored zone 1014 is in the shape of a hexagon while the remaining portion of the window 1010 is red in color. When the annular piece 1008 is near the right and left tips 1018 and 1020 of the hexagon zone 1014 the user is alerted that he or she is near an unbalanced condition for the braking mechanism.

If the difference in the front load and the weights 364 is not too great (ranging from 16-21 pounds), then the annular piece 1008 will lie within the green colored zone 1014 of the window 1010. This indicates that a balanced condition for the brake mechanism has been reached. In such a case, the male members 904 can be removed from the slots 404 via the lever actuated cables 415 and paddles even though the engagement element 902 is unbalanced.

In the case that the difference between the front load and the weights 364 is more than 16-21 pounds, the engagement element 902 and the male members 904 are prevented from being removed from the slots 404. This unbalanced condition is conveyed to the user by the annular piece 1008 lying in one of the red colored zones 1012, 1016. Depending on which red colored zone the annular piece 1008 lies, the user will need to adjust the load or weights so that the cable 1002 moves so that the annular piece 1008 is moved within the green colored zone 1014 of the window 1112. For example, if too much weight is

present on the worksurface 336, the annular piece will move to the red colored zone 1012 to the left of the green colored zone 1014. The user will then recognize that the brake mechanism is unbalanced when the annular piece 1008 is positioned in zone 1012. The user will correct the unbalanced condition by taking weight off the worksurface and/or adding weights 364 until the annular piece 1008 moves near the center of the green colored zone 1014. The center of the green colored zone 1014 representing a perfectly balanced brake mechanism. Similarly, if too little weight is present on the worksurface 336, the annular piece will move to the red colored zone 1016 to the right of the green colored zone 1014. The user will then recognize that the brake mechanism is unbalanced when the annular piece 1008 is positioned in zone 1016. The user will correct the unbalanced condition by adding weight to the worksurface and/or removing weights 364 until the annular piece 1008 moves near the center of the green colored zone 1014.

Note that other indicators 1006 are possible. For example, the cable 1002 could be attached to a sound generator where movement of the cable 1002 will cause the sound generator will generate one or more types of sounds when the brake mechanism is unbalanced and generate a different type of sound when the brake mechanism is balanced.

Note that the slider lock 945 limits the translation motion of the engagement element 902 in a manner similar to that described above with respect to the embodiment of FIGS. 54-65. For example, when the cables 415 are not actuated, the engagement element 902 is pushed toward the rack 310 by the spring 939. Since the slider lock's post 950 is within the opening 952, movement of the engagement element 902 toward the rack 310 continues until the post 950 engages the rear side of the opening 952. Similarly, when the cables 415 are actuated, movement of the engagement element 902 away from the rack 310 continues until the post 950 engages the front end of the opening 952.

In summary, the brake mechanisms of FIGS. 50-65 are intelligent in that they are able to automatically releasably engage the slots 404 based on the amount of weight supported by the worksurface 336 and the total amount of weights 364 on the counterbalance system. The brake mechanism of FIGS. 66-82 provides a simple structure that allows the user to visually identify when the worksurface is acceptably balanced and if it is not to easily adjust the load or weights until a balanced condition is reached.

As shown in FIGS. 20 and 32, attached to the car 348 is a die-cast aluminum bracket 412 which supports the worksurface 336 thereon via angle brackets 419 located at the side flanges of the bracket 412. The bracket 412 is attached to the car 348 by six screws (not shown) inserted with aligned holes 522 and 524 of the bracket 412 and car 348 and three nut plates 526. Like the bracket 35 of FIGS. 1-12, the bracket 412 includes a bottom plate 414 and flanges 416 that cooperate to support the center section 418 of the worksurface 336. Specifically, the arrangement is designed so that the center section 418 can slide in the bracket 412 to thereby allow the user to adjust the depth of the section 418. Note that worksurface 336 and the center section 418 may have a variety of shapes as shown in FIG. 33 and may be made of a variety of durable materials, such as steel, aluminum or a composite wood/plastic material of particle board and HTPL. The worksurface 336 may have a front edge that is made of plastic.

The bracket 412 is preferably configured to support an elevated platform 420 on top of the bracket 412. The platform 420 is structurally similar to the platform 73 of FIGS. 1-12 and is preferably configured so as to be adjustable in height and depth. As depicted, this is most preferably accomplished by providing a series of front holes 422 and back holes 424 in the platform 420. Bolts or pins are inserted through the front holes 426 on the bracket 412 and one of the front holes 422 in the platform 420. Likewise, bolts or pins are inserted through the back holes 428 in the bracket 412 and one of the back holes 424 in

the platform 420. In this way, the height depth, and even the angle of the platform 420 can be adjusted relative to the rest of the worksurface 336. A worksurface 600, such as shown in FIG. 38 and similar in structure to worksurface 336, can be attached to the top of the platform 420.

In the manner described previously with respect to the workstation of FIGS. 1-12, the platform 420 preferably supports a computer monitor and/or keyboard 429. Alternatively, the platform 420 can be made large enough to hold two or more computer monitors. Straps like the straps 14 may be included to secure the monitors or other equipment to the platform 420.

The above description shows how the invention of FIGS. 13-38 provides for a workstation 300 that can easily adjust the position of a worksurface 336 over a wide range of positions. The workstation 300 also provides the advantage of being compactible and collapsible so as to be easily moved from room to room. The structure that provides the advantage is discussed below.

As shown in FIGS. 14-15 and 20, the base 304 has four rollers 430 attached at the four corners of the base 304. The base 304 is also has two identical generally horizontal legs 432, 434 pivotably attached to the base's two front corners. As shown in FIG. 39, the axles 436 of the front rollers 430 are inserted through the washers 526 and the front openings 438 of the base 304 and are inserted into the rear bottom openings 440 of the legs 432, 434. In addition, pins 441 are inserted through the openings 443 of the L-shaped elements 314 and the front openings 438 of the base 304. The legs 432 and 434 pivot about the axles 436 between a use position and a collapsed position. In the use position, similar to that shown in Figures 1-3, the legs 432 and 434 are spread away from each other thereby preventing interference with the feet or chair of the user. In the collapsed position, similar to that shown in Figure 4, the legs 432 and 434 are pivoted toward each other to allow the workstation 300 to pass through a doorway, preferably a 30 inch doorway. The legs 432, 434 include rollers 442 so that in combination with rollers 430 of the base, the

workstation 300 can be readily moved along a floor. Most preferably, the rollers 430 and 442 are omni-directional castors. Alternatively, the rollers can be wheels. Preferably, at least some of the rollers are equipped with a conventional brake. Naturally, the rollers should be able to roll over various types of floors and minor obstacles.

The legs 432 and 434 are locked into either the use position or the collapsed position by a lever 444 that is pivotably attached to a male element 446 via a lifting rod 528 and pin 530. The lifting rod 528 is inserted through an opening 531 that extends through the leg and is inserted and attached within an opening 532 of the male element 446 via a pair of clips 534 that are inserted into grooves 536 that are positioned above and below the male element 446. The male element 446 is biased downward via a spring 538 that is housed in an opening 540 of the leg and centered about a protrusion 542 on the top of the male element 446. The vertical movement of the male element 446 is assured by a guide rod 544 that moves within an opening 546 of the leg. The guide rod 544 is attached within a second opening 548 of the male element 446 via clips 550 and grooves 552 in a manner similar to the attachment of the clips 534 and the grooves 536. Lifting the lever 444 causes the male element 446 to be raised into the housing of the leg and lowering the lever 444 causes the male element 446 to be lowered below the housing of the leg.

In operation, the legs 432 and 434 are positioned over a first pair of engaging elements associated with the use position, such as the openings 448 formed in the base 302. At the use position, the levers 444 of the legs 430 and 442 are lowered causing the male elements 446 to enter the openings 448 and locking the legs into the use position. Locking the legs at the use position improves the stability of the workstation 300 during its use. If the legs 432 and 434 are to be moved to the collapsed position, the levers 444 are pivoted upwards so as to lift the male elements 446 out of the openings 448. The legs 432 and 434 are pivoted inwards over the protrusions 450 and are positioned

over a second pair of engaging elements associated with the collapsed position, such as the openings 452 formed in the base 302. Once positioned at the collapsed position, the levers 444 are lowered so that the male elements 446 are inserted into the openings 452 so as to lock the legs in the collapsed position. Locking the legs at the collapsed position helps to prevent accidental movement and wobbling of the legs during translational movement of the workstation.

Another way of locking the legs 432 and 434 is shown in FIGS. 83-85. As shown in FIG. 83, a pair of metal plates 800 (only one shown) are attached to the underside of the base 304 via bolts inserted through the openings 802. The metal plate 800 has a pair of openings 804 and 806 that extend past the edge of the base 304. The openings 804 and 806 function similarly to the openings 448 and 452, respectively, in that they provide openings for a male element to be therethrough when the legs are to be positioned and locked at use and collapsed positions. An embodiment of a male element is the vertically moving rod 808 shown in FIG. 83. The rod 808 is attached to a pivoting arm 810 via a pin 812. The pivoting arm 810 is positioned within a longitudinal slot 812 formed in each leg 432, 434 so as to extend end to end along the length of the leg where the round end 814 is positioned nearer the center of the leg than the cammed end 816. As shown in FIG. 83, the cammed end 816 of the pivoting arm 810 has an opening 818 to receive the pin 812 so as to attach the rod 808 thereto. The cammed end 816 also has a curved or cammed surface 818 that faces downward and has a length of approximately 2.44 inches and a depth of approximately 0.44 inches.

The pivoting arm 810 is trapped within the slot 812 by a metal bracket 820 that is attached to the underside of the leg 432, 434 by four shoulder bolts 822 that are inserted through corresponding bracket slots 824 and engage openings 826 formed in the bottom of the leg. Washers 828 and spacers 830 are used for attaching the bolts 822 as well. The bolts 822 and the slots 824 allow the bracket 820 to translate along the bottom surface of the leg 432, 434. Once

the bracket 820 is attached a roller or bushing 832 of the bracket 820 contacts the cammed surface 818. In addition, a spring (not shown) is inserted into a leg opening 834 so as to contact the top edge of the pivoting arm 810 so as to bias the arm 810 downward and towards the bottom of the leg 432, 434.

In operation, the legs 432 and 434 are positioned over a first pair of engaging elements associated with the use position, such as the openings 804 formed in the base 304. At the use position, the bracket 820 is slid toward the opening 804 (to the left as shown in FIG. 83) so that the bushing 832 engages the portion of the cammed surface 818 nearest the end 816. At this position, the spring pushes the rod 808 downward so that its beveled end 836 is inserted into the opening 804. If the legs 432 and 434 are to be moved to the collapsed position, the bracket 820 is slid away from the opening 804 so that the bushing 832 rides on the cammed surface 818 that causes the pivoting arm 810 to pivot about the end 814 so that the arm 810 and the rod 808 overcome the spring and move upward and away from the bottom of the leg 432, 434. The legs 432 and 434 are pivoted inwards and are positioned over a second pair of engaging elements associated with the collapsed position, such as the openings 806. Once positioned at the collapsed position, the brackets 820 are slid toward the openings 806 so that the rods 808 for each leg are inserted into the openings 806 so as to lock the legs in the collapsed position.

Another way of collapsing the workstation 300 for movement through a doorway, is to hinge the right side 454 and left side 456 of the worksurface 336. This is accomplished by attaching two hinges 458 to the sides of the bracket 412. Attached to the hinges 458 are the right side 454 and left side 456 of the worksurface 336. As a result, the sides 454 and 456 can be moved between a horizontal position (see Figures 1-3 and 13A-B as an example) to a collapsed or vertical position (see Figures 4 and 13C as an example), thereby allowing the workstation 300 to be more easily passed through a doorway. As with the workstation of FIGS. 1-12, the sides can alternatively be

made to pivot horizontally so as to pivot into a retracted position. Also, the sides can be made to be easily detached and reattached so as to provide the collapsibility for the workstation to pass through doorways.

In the use position, pivoting supports 460 and 462 are provided to support the bottom surfaces of the sides 454 and 456, respectively. The pivoting supports 460 and 462 have the same shape and structure as the legs 432 and 434 shown in FIGS. 39-44 or FIGS. 83-85. However, the supports 460 and 462 are flipped upside down when compared with the legs 432 and 434. Bolts (not shown) are inserted through the openings 464 formed in the ears 466 of the car 348, through the rear top openings 468 of the supports 460, 462 and through the bushings 524. The supports 460 and 462 pivot about the bolts between a use position and a collapsed position. In the use position, the supports 460, 462 are spread away from each other so that their leveling guides 470 lie underneath and support the sides 454 and 456, respectively, thereon. The leveling guides 470 threadedly engage an opening in the supports so that rotation of the guides causes the sides to move relative to the center section 418 until the sides 454 and 456 are level with the center section 418. In the collapsed position, the supports 460, 462 are pivoted toward each other to allow the workstation 300 to pass through a doorway, preferably a 30 inch doorway. Note that prior to the supports 460, 462 being moved to the collapsed position, the sides 454 and 456 are moved to the collapsed or vertical position.

In the case of using the structure of the legs 432, 434 of FIGS. 39-44, the supports 460 and 462 are locked into either the use position or the collapsed position by the lever 444 and male element 446. Since the supports 460, 462 are upside down relative to legs 432 and 434, lowering the lever 444 away from the housing of the supports causes the male element 446 to be moved into the housing of the leg and raising the lever 444 towards the housing of the support causes the male element 446 to be raised out of the housing of the support.

In operation, the supports 460 and 462 are positioned underneath a first pair of engaging elements associated with the use position, such as the openings 464 formed in the bottom surface of the bracket 412. At the use position, the levers 444 of the supports 460 and 462 are raised towards the housing of the supports causing the male elements 446 to enter the openings 464 and locking the supports into the use position. If the supports 460 and 462 are to be moved to the collapsed position, the levers 444 are pivoted downwards so as to lift the male elements 446 out of the openings 464. The supports 460 and 462 are pivoted inwards over the protrusions 466 and are positioned over a second pair of engaging elements associated with the use position, such as the openings 468 formed in the bottom surface of the bracket 412. Once positioned at the collapsed position, the levers 444 are raised towards the housings of the supports so that the male elements 446 are inserted into the openings 468.

In the case of using the structure of the legs 432, 434 of FIGS. 83-85, the supports 460 and 462 are locked into either the use position or the collapsed position by the bracket 820 and the rod 808. Moving the bracket 820 longitudinally toward the center of the support causes the rod 808 to be moved into the housing of the support and moving the bracket 820 away from the center of the support causes the rod 808 to be raised via the spring out of the housing of the support.

In operation, the supports 460 and 462 are positioned underneath a first pair of engaging elements associated with the use position, such as the openings 464 formed in the bottom surface of the bracket 412. At the use position, the brackets 820 are slid away from the center of the supports causing the rods 808 to enter the openings 464 and locking the supports into the use position. If the supports 460 and 462 are to be moved to the collapsed position, the brackets 820 are slid toward the center of the support causing the spring to pivot the pivot arm 810 and the rod 808 downwards so as to remove the rods 808 out of the openings 464. The supports 460 and 462 are pivoted inwards and are

positioned over a second pair of engaging elements associated with the use position, such as the openings 468 formed in the bottom surface of the bracket 412. Once positioned at the collapsed position, the brackets 820 are slid away from the center of the supports so that the rods 808 are inserted into the openings 468.

Support plates 554 can be attached within recesses 556 formed in the bottoms of the sides 454 and 456 and the center section 418 in a manner similar to the attachment of the support plates of FIG. 8. These plates serve to support the center section, particular as it slides in and out of the bracket 412.

The workstation 300 also preferably includes display panels 470 and 472 which are supported above the worksurface 336 and are adapted to move up and down with the worksurface. These panels 470 and 472 are preferably equipped with clips 474 or the like to hold papers or other objects for the workstation user. Preferably, the display panels 470 and 472 are supported on identical bent bars 476 and 478 as shown in FIGS. 46 and 47. Most preferably, the display panels are pivotably attached to the bars so as to be adjustable between a vertical position and a horizontal position, and to be adjustable between a use position (see Figures 1-3 and 13A-B as an example) and a collapsed position (see Figures 4 and 13C as an example). As shown in FIGS. 20 and 49, adjustment between the vertical and horizontal positions is preferably accomplished with a pivotable adjustment element 480 that has a pair of channels 556 that receive a pivot rod 558 that is received in a channel formed in a side of the display panels 470 and 472. The adjustment element 480 has an ear 560 that frictionally engages an O-ring attached at one end 562 of the bent die-cast bars 476 and 478. The ear 560 and the end 562 have threaded openings that are aligned with each other and receive a threaded locking handle 564 therein. The bars 476 and 478 each have an end 566 that has an engagement surface 482 that has alternating ridges and channels arranged in an annulus like the ridges and channels of a poker chip. The ridges of the

engagement surface 482 engage the channels of a similarly shaped engagement surface 484 of an L-shaped bracket 486 (see FIG. 48) that is mounted to the rear outer edges of the bracket 412. The end 566 and the bracket 486 have threaded openings aligned with each other and centered with the annulus of the ridges and channels. A threaded locking handle 568 is inserted into the aligned openings of the end 566 and the bracket 486.

The bars 476 and 478 in conjunction with the adjustment element 480 and the bracket 486 provide up/down adjustment of the panels 470 and 472 in either a vertical or horizontal position. Horizontal adjustment is provided by rotating the display panels 470 and 472 about the pivot rod 558. Vertical adjustment is provided by either pivoting the display panels 470 and 472 about an axis aligned with the opening of the adjustment element 480 and tightening the locking handle 564 at the desired vertical position. Vertical adjustment can also be adjusted by pivoting the bars 476 and 478 about an axis aligned with the opening of the bracket 486 and tightening the locking handle 568. Besides adjustment of the positions of the display panels 470 and 472, the bars 476 and 478 and the bracket 486 reduce obstruction to the rear areas of the sides 454 and 456.

The workstation 300 also may include lights similar to the lights 122 and 124 of the embodiment of FIGS. 1-12 that are mounted to the display panels 470 and 472 so as to move up and down with the worksurface 17. Still other equipment for the user may also be mounted to the workstation, such as a telephone or audio speakers.

The foregoing description is provided to illustrate the invention, and is not to be construed as a limitation. Numerous additions, substitutions and other changes can be made to the invention without departing from its scope as set forth in the appended claims.

WE CLAIM:

1. A workstation comprising

a column;

a height adjustment mechanism adapted to travel up and down the length of the column and to be fixed at desired positions;

a brake mechanism for fixing the position of the height adjustment mechanism by automatically releasably engaging said vertical column based on the amount of weight supported by said height adjustment mechanism, wherein said brake mechanism comprises an engagement element mounted within a bounded area that is bounded by a pair of spacers.

2. The workstation of claim 1, comprising a worksurface attached to the height adjustment mechanism.

3. The workstation of claim 1, wherein said engagement element pivots and said brake mechanism controls pivotal motion of said engagement element.

4. The workstation of claim 1, wherein said engagement element translates and said brake mechanism controls translational motion of said engagement element.

5. The workstation of claim 3, wherein said engagement element translates and said brake mechanism controls translational motion of said engagement element.

6. The workstation of claim 3, comprising a brake balancer that generates a force that counteracts the pivoting motion of said engagement element.

7. The workstation of claim 6, wherein when said generated force overcomes said pivoting motion said engagement element is prevented from being released from said vertical column.

8. The workstation of claim 6, wherein when said generated force does not overcome said pivoting motion said engagement element is releasable from said vertical column.

9. The workstation of claim 7, wherein when said generated force does not overcome said pivoting motion said engagement element is releasable from said vertical column.

10. The workstation of claim 1, wherein said brake comprises a rack mounted on the vertical column and an engaging element biased into engagement with the rack.

11. The workstation of claim 10, wherein said engaging element comprises a male engagement member that is inserted into a slot formed in said rack.

12. The workstation of claim 1 wherein the height adjustment mechanism comprises a first and a second track.

13. The workstation of claim 12, wherein the height adjustment mechanism includes a first wheel which rolls within the first track and a second wheel which rolls within the second track.

14. The workstation of claim 2 wherein the height adjustment mechanism comprises a weight counterbalance system to assist in raising the worksurface and any equipment thereon.

15. The workstation of claim 1, further comprising a brake balancer that engages a side of said engagement element.

16. The workstation of claim 15, wherein said brake balancer comprises a spring.

17. The workstation of claim 15, wherein said brake balancer causes a portion of said engagement element to enter a recess formed in said bounded area.

18. The workstation of claim 17, wherein said portion is an ear formed in said engagement element.

19. The workstation of claim 15, further comprising a second brake balancer that is a mirror image of said brake balancer.

20. The workstation of claim 15, wherein said brake balancer causes said engagement element to pass between said spacers.

21. A workstation comprising
a column;
a height adjustment mechanism adapted to travel up and down the length of the column and to be fixed at desired positions;
a brake mechanism for fixing the position of the height adjustment mechanism and which releasably engages said column, wherein said brake mechanism comprises an indicator system that indicates to a user whether or not said brake mechanism is balanced.

22. The workstation of claim 21, comprising a worksurface attached to the height adjustment mechanism.

23. The workstation of claim 21, wherein said brake comprises an engagement element.

24. The workstation of claim 23, wherein said engagement element pivots and said brake mechanism controls pivotal motion of said engagement element.

25. The workstation of claim 23, wherein said engagement element translates and said brake mechanism controls translational motion of said engagement element.

26. The workstation of claim 24, wherein said engagement element translates and said brake mechanism controls translational motion of said engagement element.

27. The workstation of claim 24, comprising a brake balancer that generates a force that counteracts the pivoting motion of said engagement element.

28. The workstation of claim 27, wherein when said generated force overcomes said pivoting motion said engagement element is prevented from being released from said vertical column.

29. The workstation of claim 27, wherein when said generated force does not overcome said pivoting motion said engagement element is releasable from said vertical column.

30. The workstation of claim 28, wherein when said generated force does not overcome said pivoting motion said engagement element is releasable from said vertical column.

31. The workstation of claim 21, wherein said brake comprises a rack mounted on the vertical column and an engaging element biased into engagement with the rack.

32. The workstation of claim 31, wherein said engaging element comprises a male engagement member that is inserted into a slot formed in said rack.

33. The workstation of claim 32 wherein the height adjustment mechanism comprises a weight counterbalance system to assist in raising the worksurface and any equipment thereon.

34. The workstation of claim 33, further comprising a brake balancer that engages a side of said engagement element.

35. The workstation of claim 34, wherein said brake balancer comprises a spring.

36. The workstation of claim 34, further comprising a second brake balancer that is a mirror image of said brake balancer.

37. The workstation of claim 21, wherein said indicator system is a visual indicator system.

38. The workstation of claim 37, further comprising a brake balancer that engages said engagement element; and

said visual indicator system comprises:

a cable attached to said brake balancer; and

a window that allows a user to view a portion of said cable.

39. The workstation of claim 38, wherein said window comprises a zone that indicates that the brake mechanism is balanced when said portion of said cable is within said zone.

40. The workstation of claim 38, wherein said window comprises a zone that indicates that the brake mechanism is not balanced when said portion of said cable is within said zone.

41. The workstation of claim 40, wherein said window comprises a second zone that indicates that the brake mechanism is balanced when said portion of said cable is within said second zone.

42. The workstation of claim 41, wherein said first and second zones are colored differently from one another.

43. The workstation of claim 39, wherein said zone is in the shape of a hexagon.

44. A method of balancing a brake mechanism that fixes the position of a height adjustment mechanism adapted to travel up and down a length of a column, the method comprising:

detecting a balancing force applied to an engagement element of said brake mechanism and that counteracts pivoting of said engagement element; and

indicating to a user whether said braking mechanism is balanced based on said detecting.

45. The method of claim 44, comprising a worksurface attached to the height adjustment mechanism.

46. The method of claim 44, wherein said indicating comprises visually indicating to a user whether said braking mechanism is balanced based on said detecting.

47. The method of claim 46, wherein said indicating comprises viewing a window to see whether or not a visual indicator is within a zone of said window that represents a balanced condition of said brake mechanism.

48. The method of claim 47, wherein if said visual indicator is not within said zone then said user takes steps to balance said brake mechanism.

49. The method of claim 45, wherein said indicating comprises visually indicating to a user whether said braking mechanism is balanced based on said detecting.

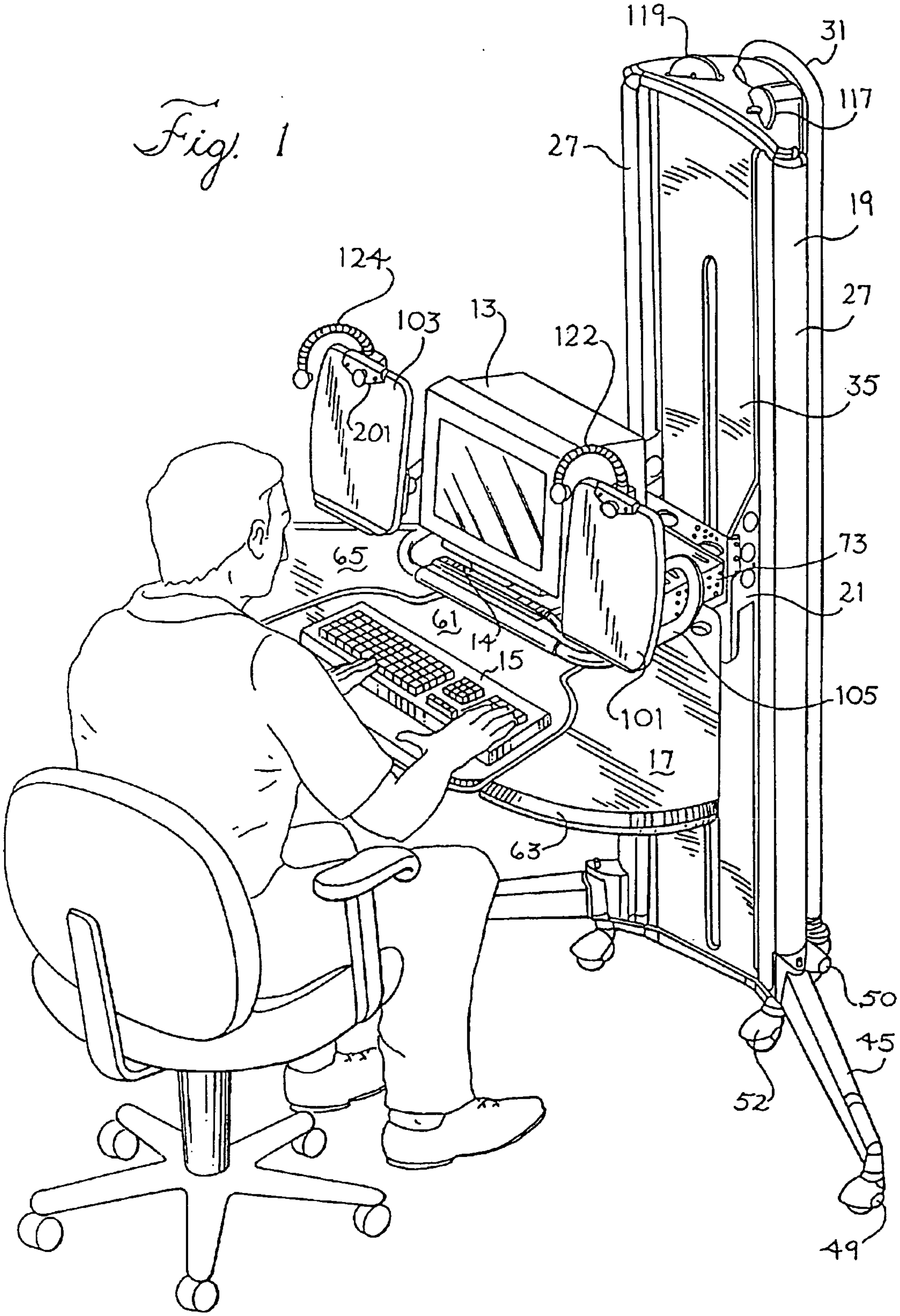
50. The method of claim 49, wherein said indicating comprises viewing a window to see whether or not a visual indicator is within a zone of said window that represents a balanced condition of said brake mechanism.

51. The method of claim 50, wherein if said visual indicator is not within said zone then said user adds or removes weight from said worksurface until said visual indicator is within said zone.

52. The method of claim 50, wherein if said visual indicator is not within said zone then said user adds or removes weights of said height adjustment mechanism until said visual indicator is within said zone.

53. The method of claim 51, wherein if said visual indicator is not within said zone then said user adds or removes weights of said height adjustment mechanism until said visual indicator is within said zone.

Fig. 1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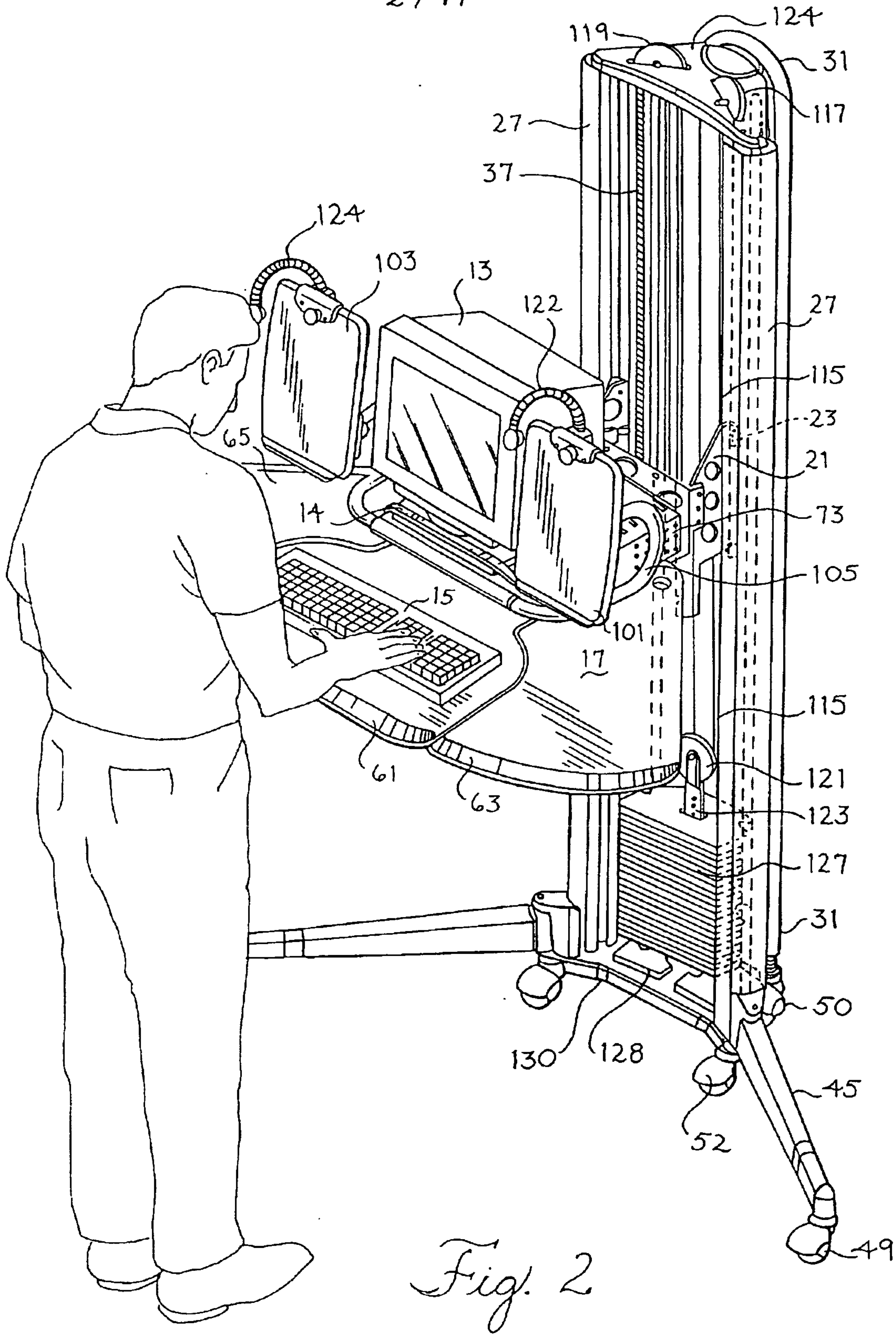
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Fig. 2

Fig. 3

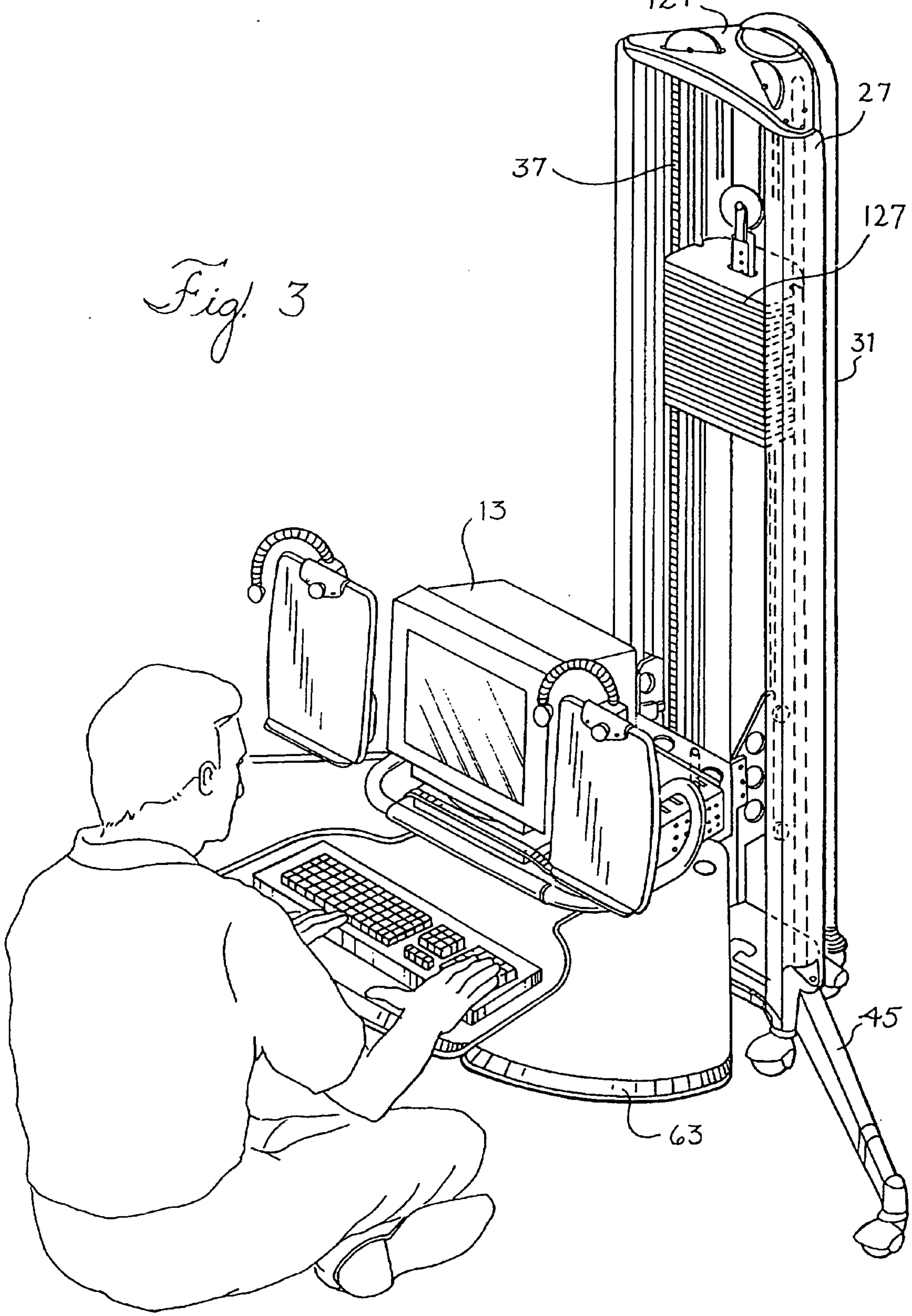
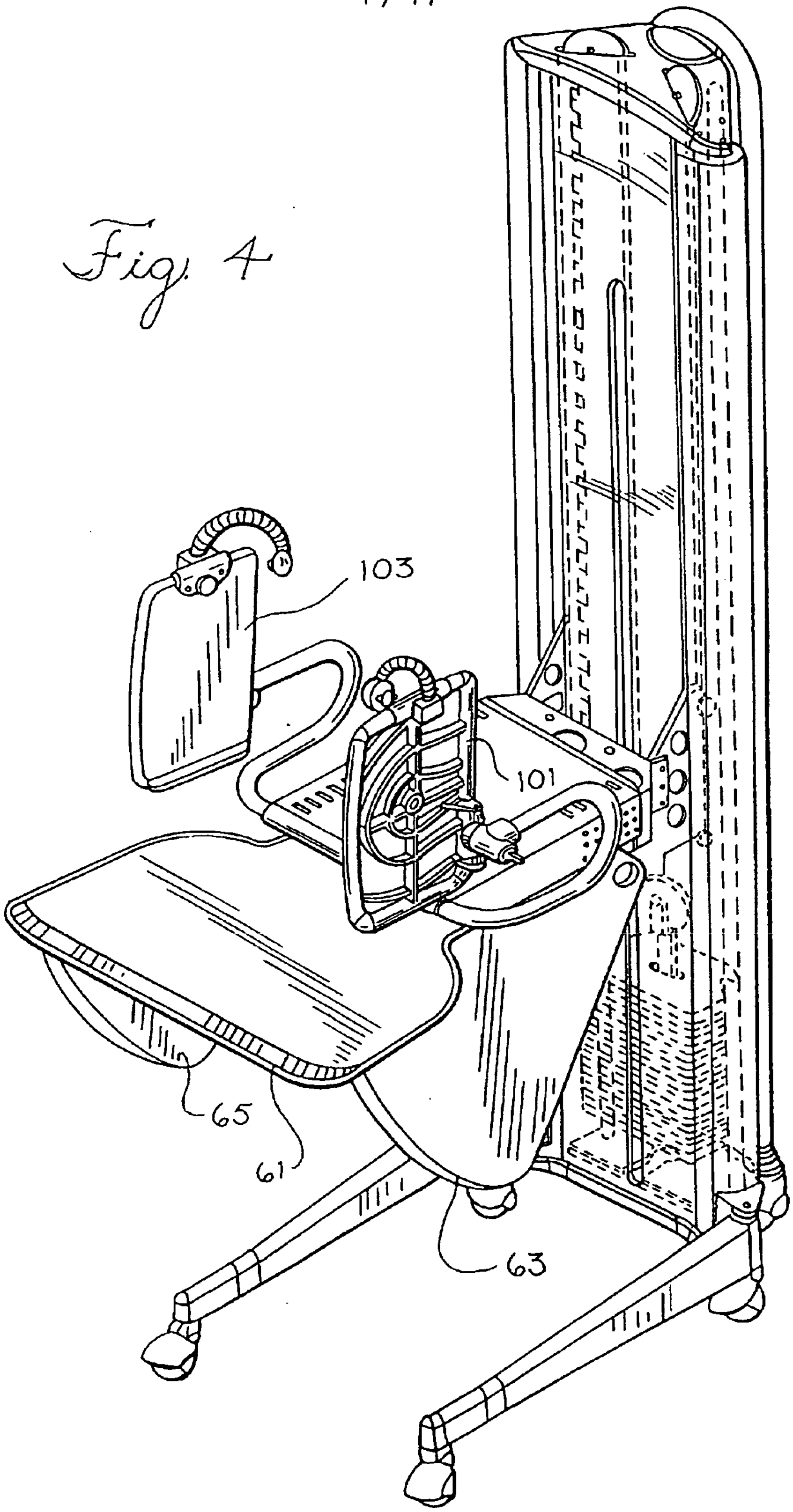


Fig. 4



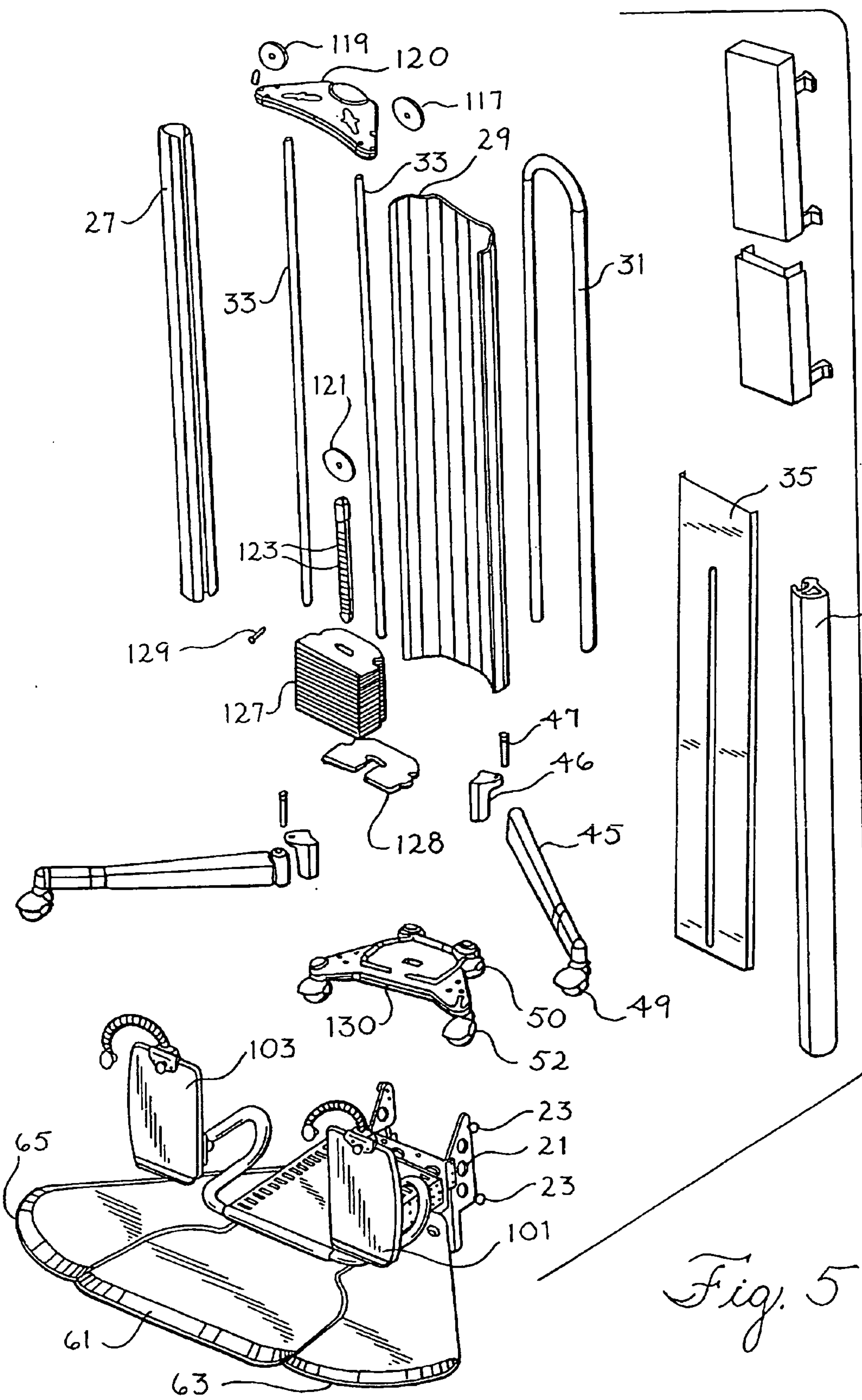

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Fig. 5

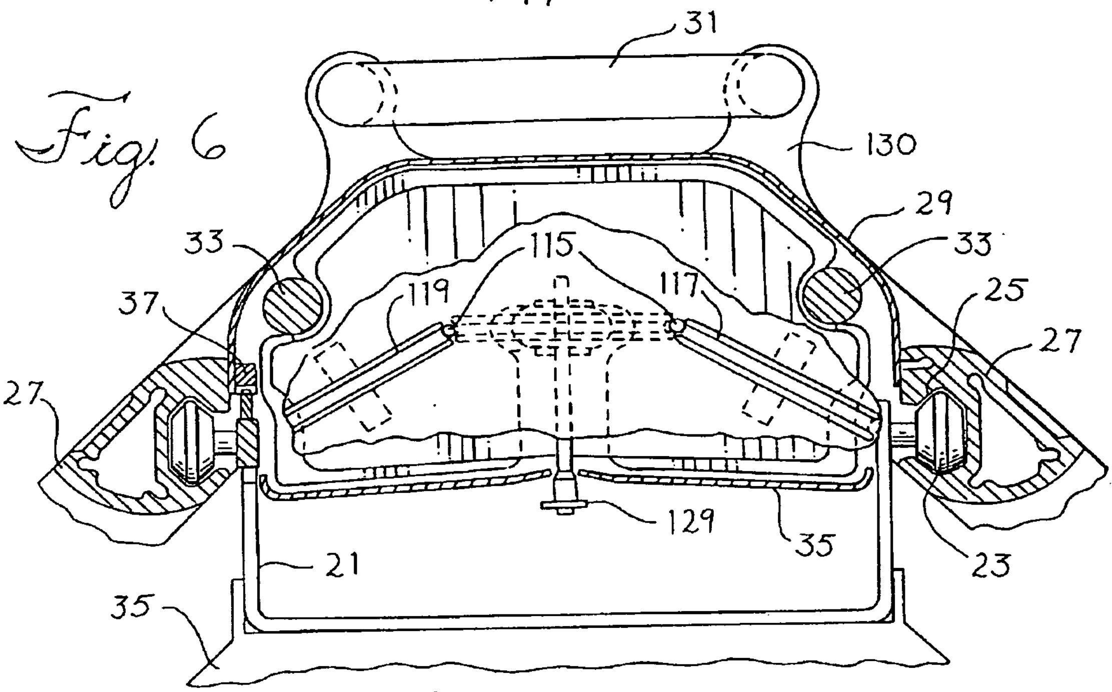

Fig. 6

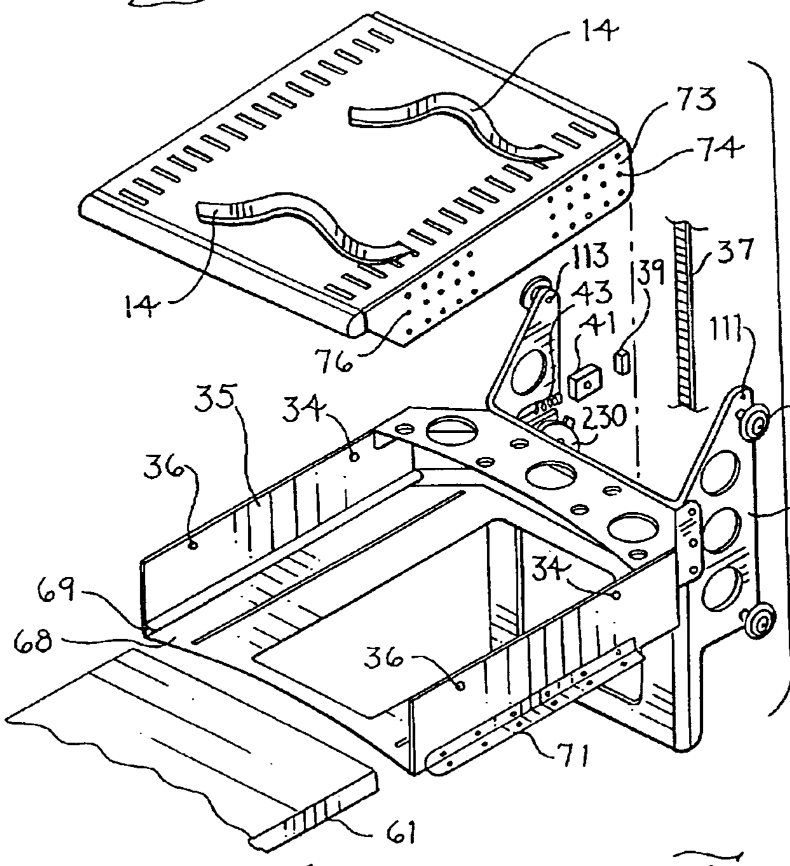

Fig. 7

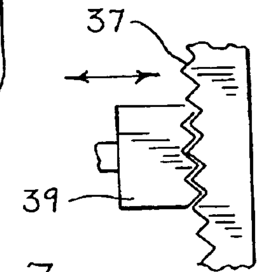

Fig. 7a

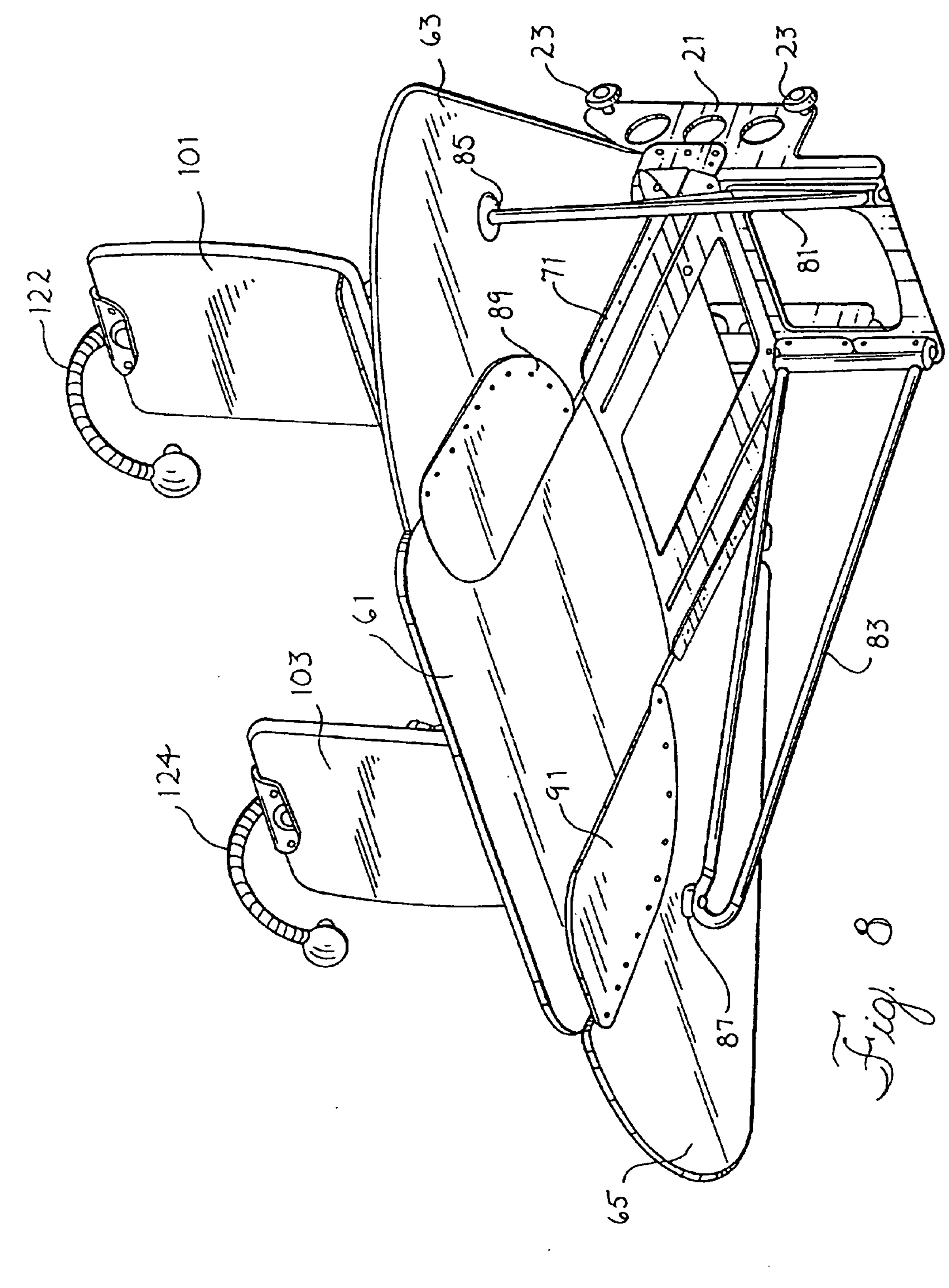

Fig. 8

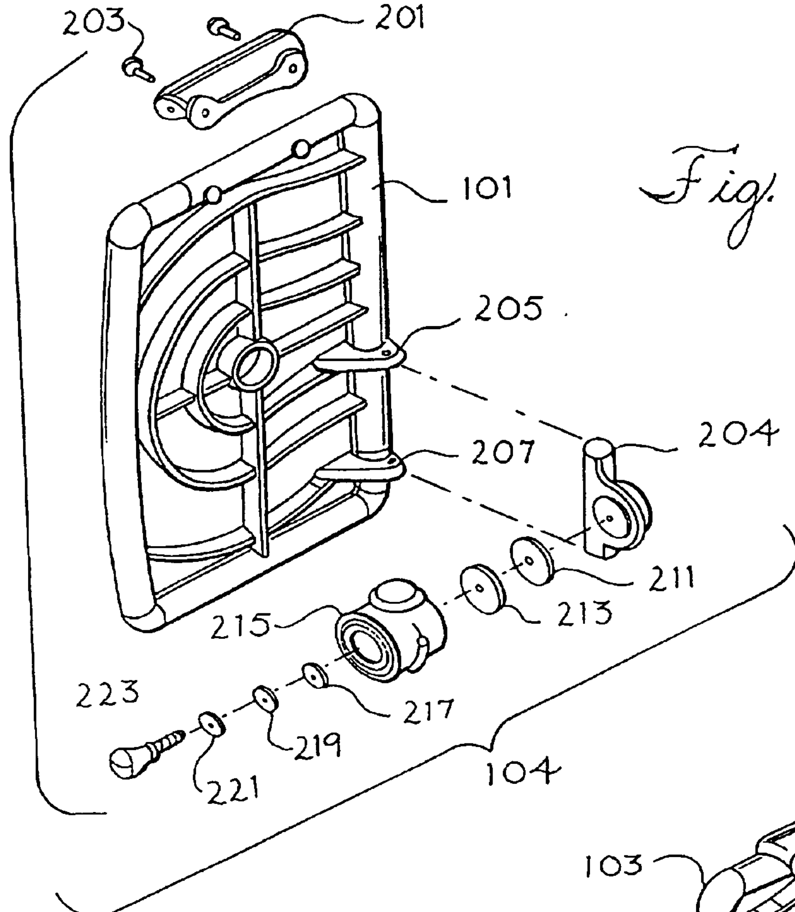

Fig. 10

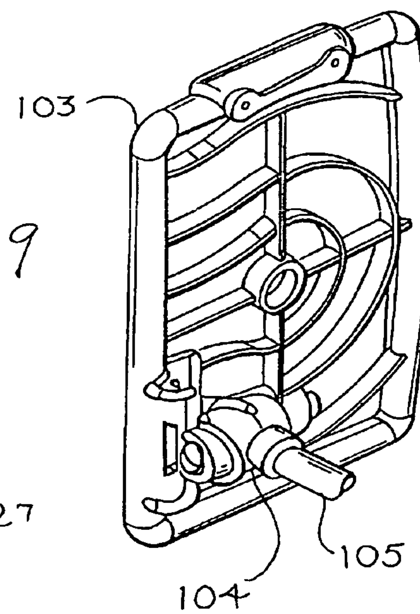

Fig. 9

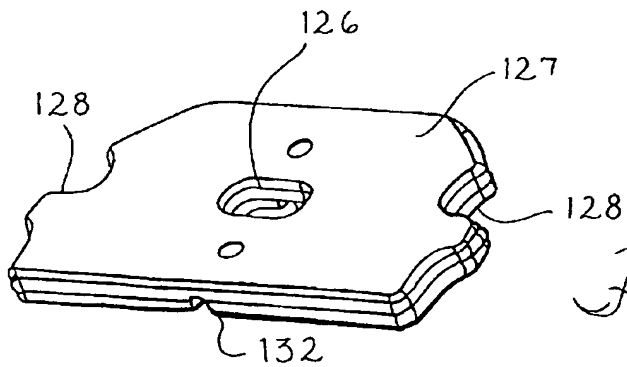

Fig. 5a

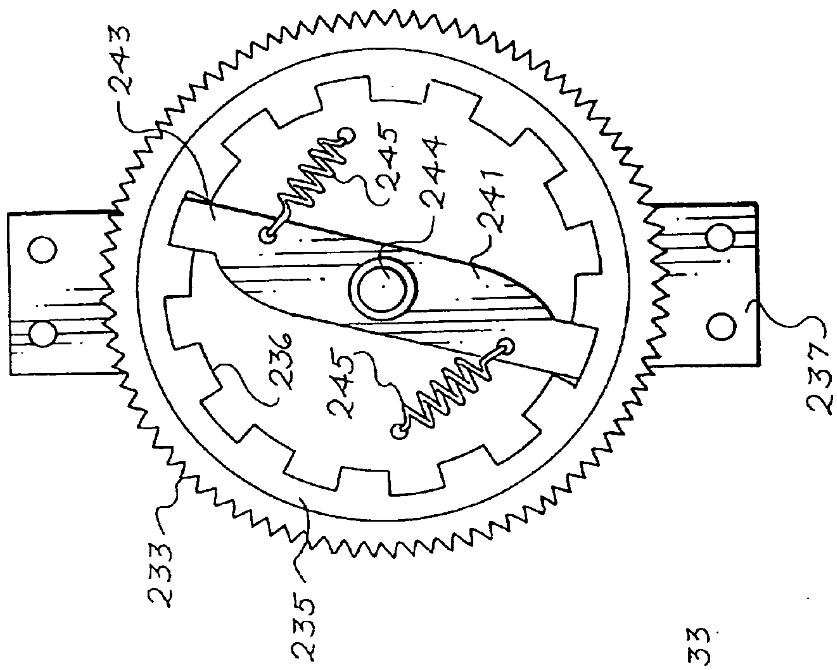
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Fig. 12

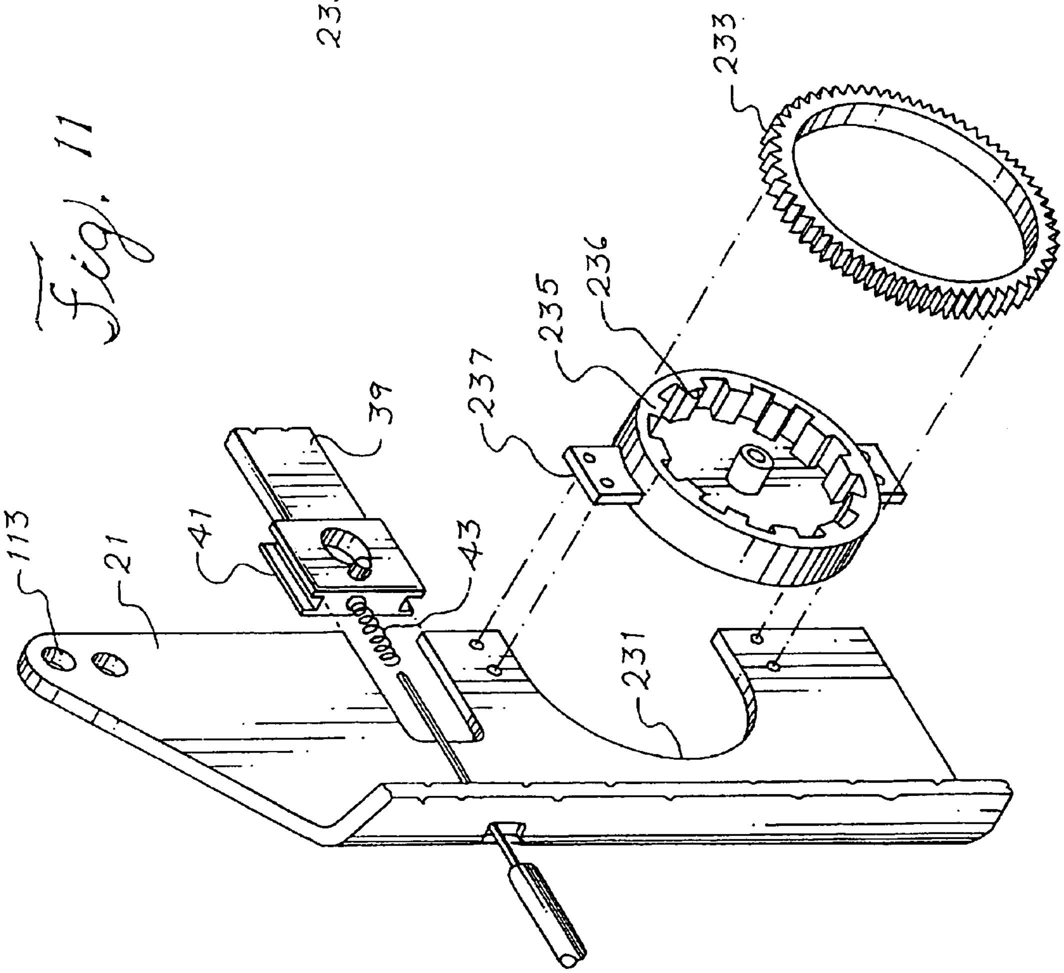
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Fig. 11

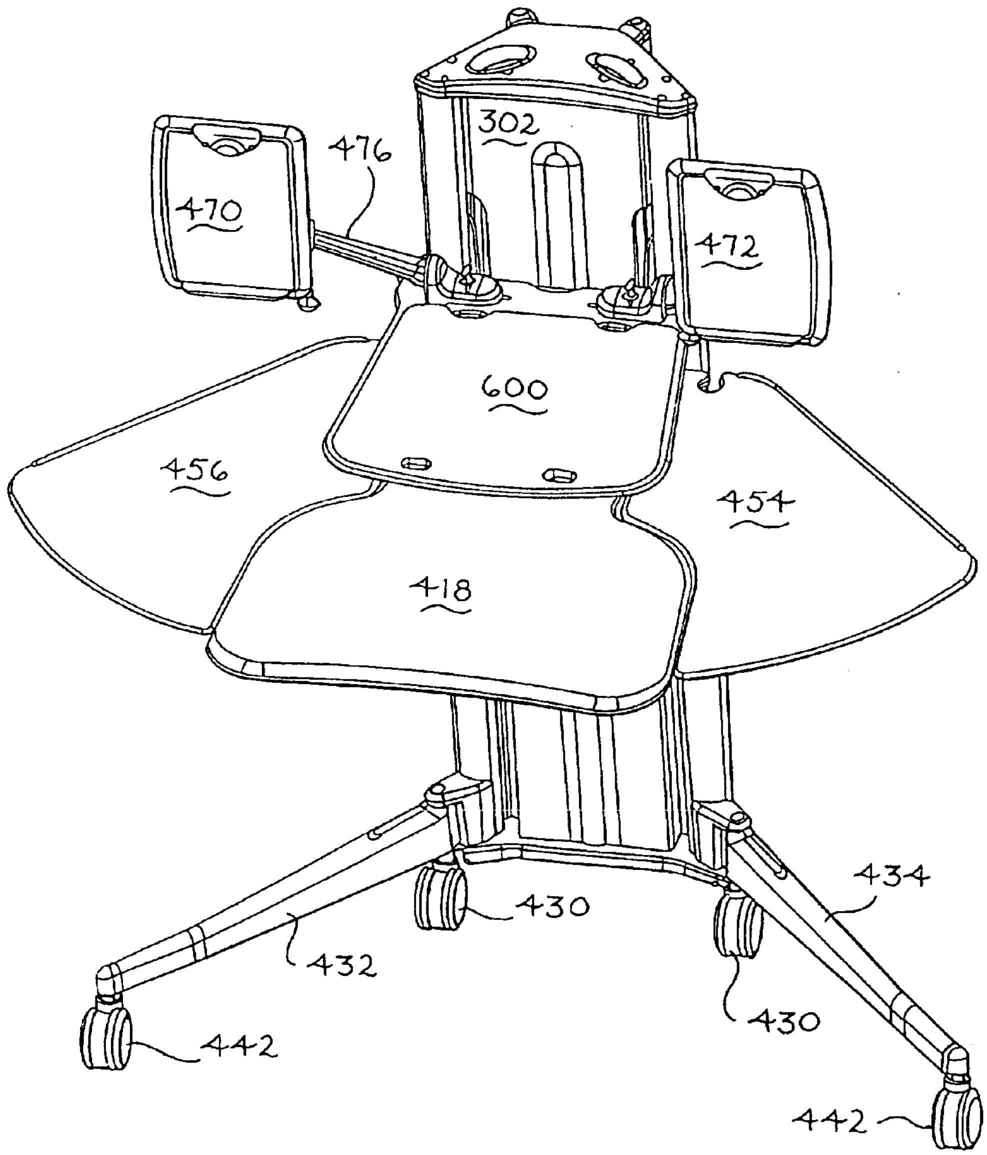

Fig. 13A

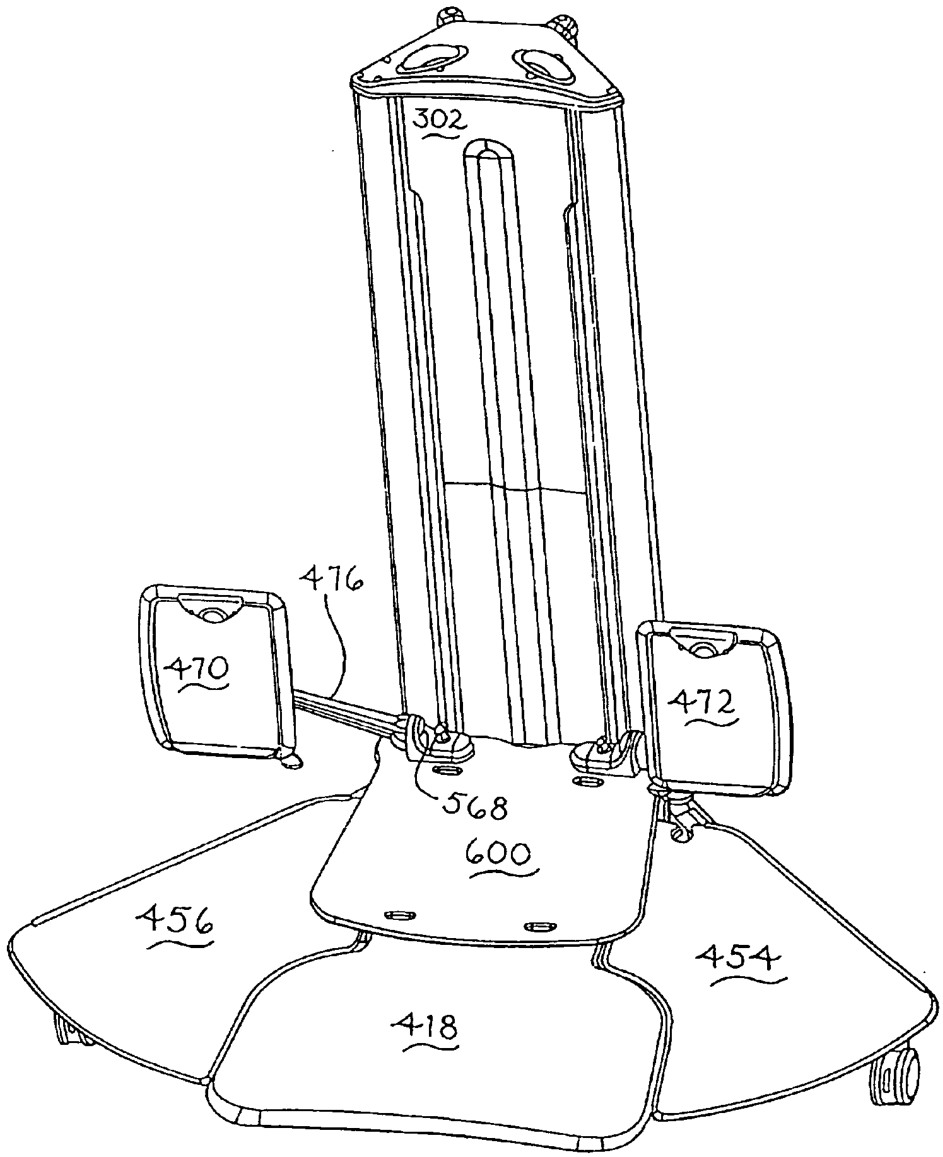

Fig. 13B

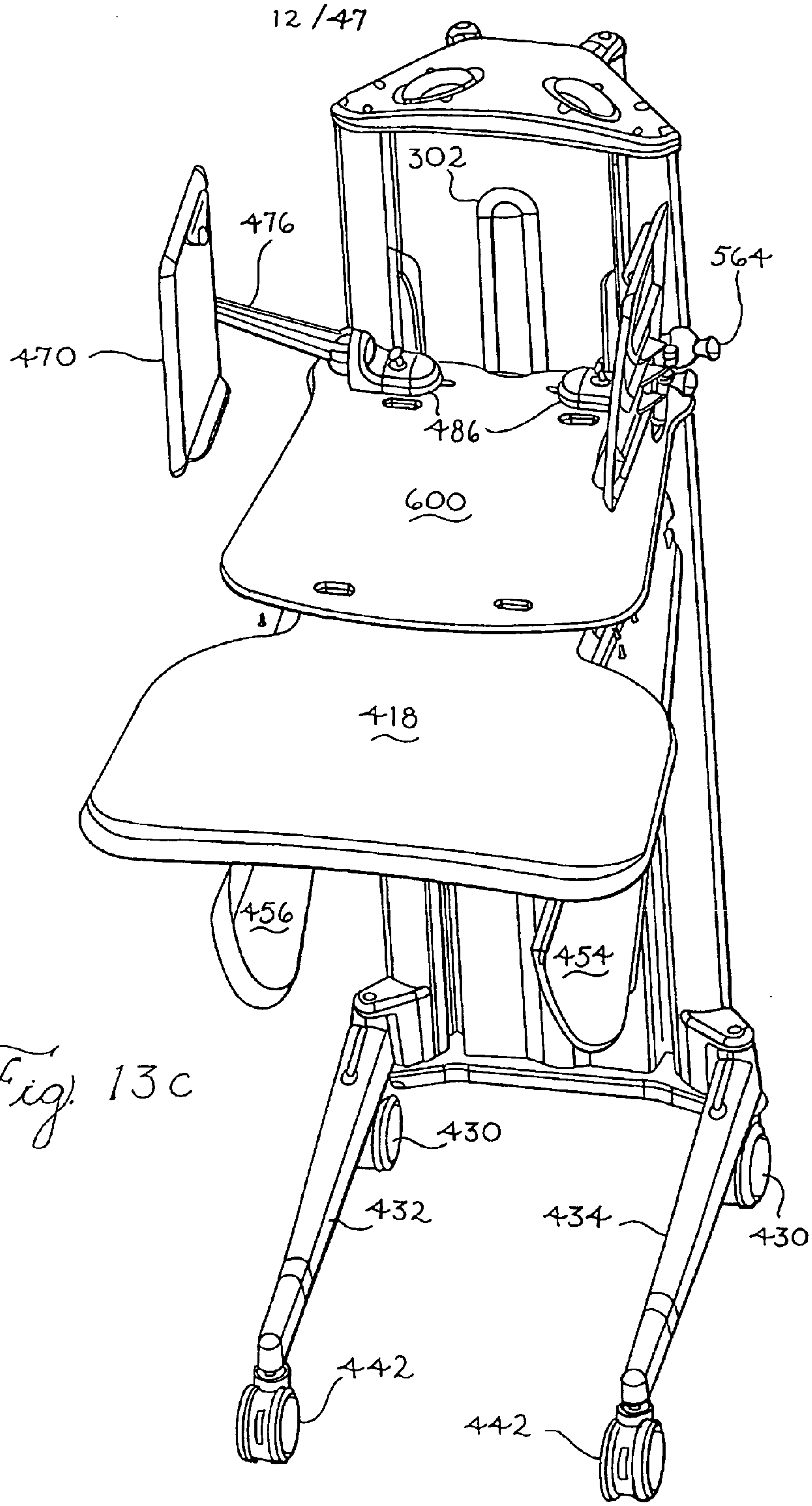

Fig. 13c

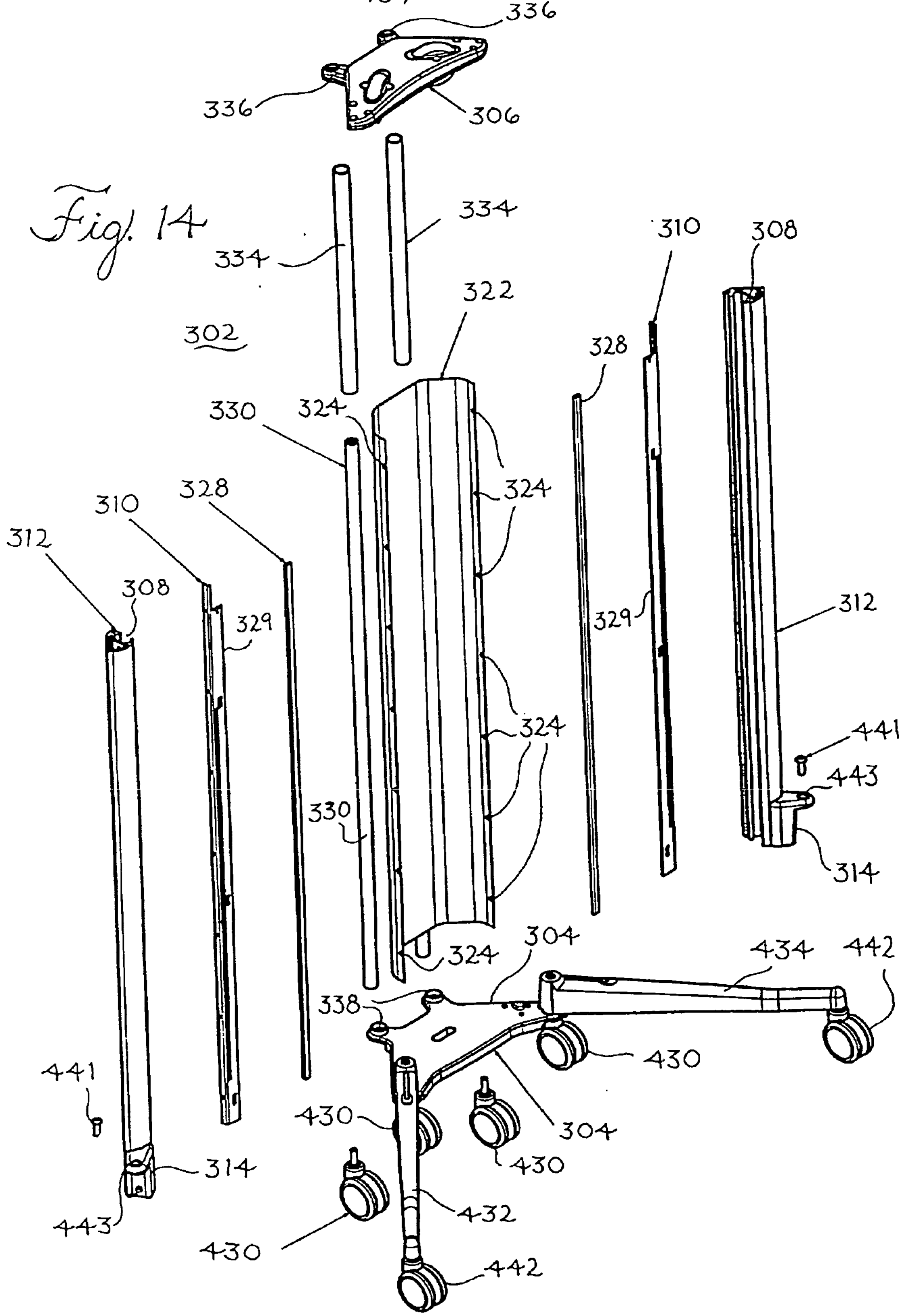
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Fig. 14

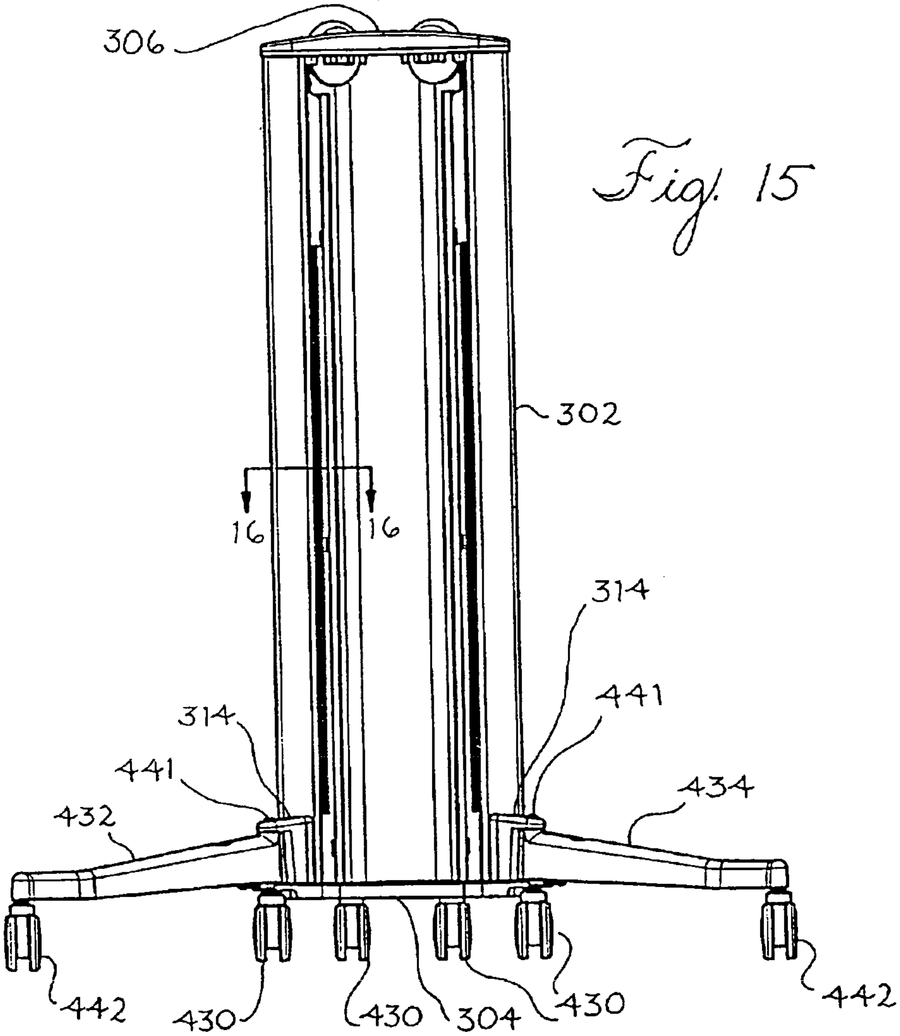
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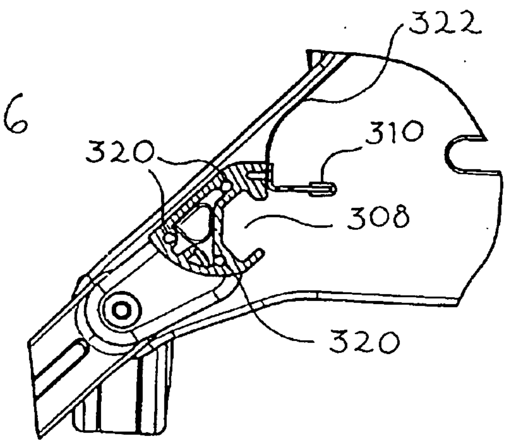
Fig. 15

Fig. 16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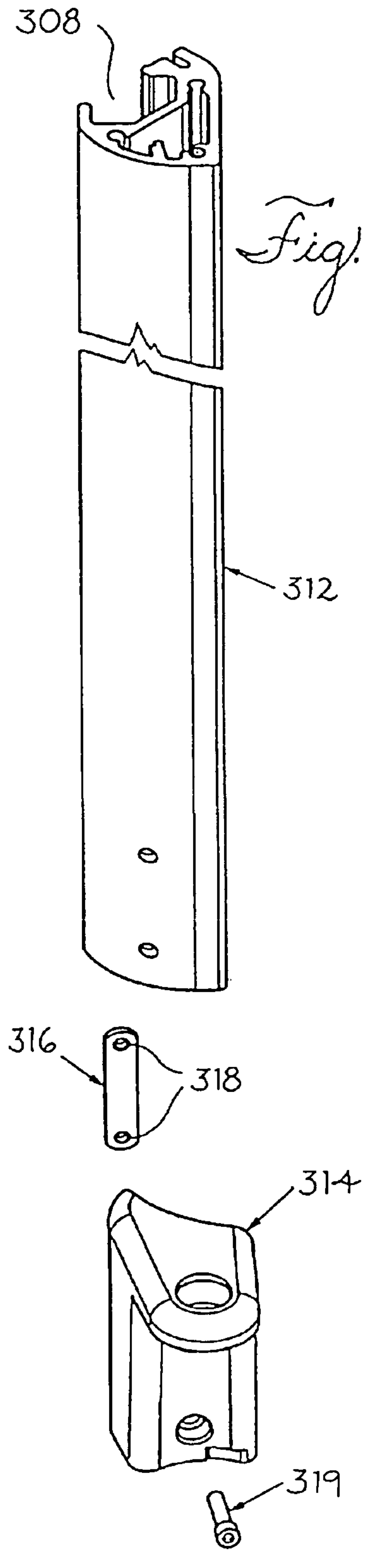
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Fig. 17

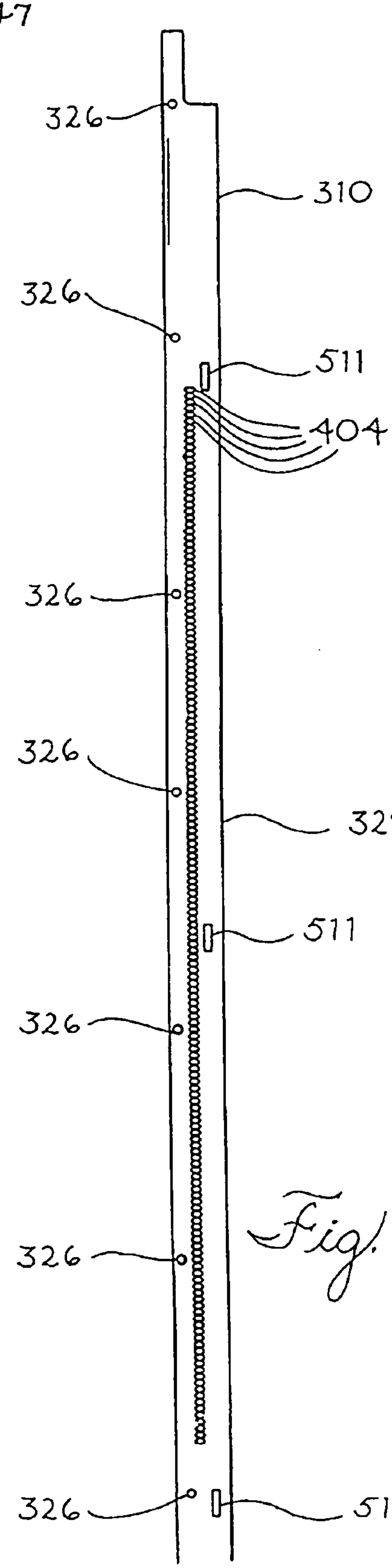
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Fig. 18

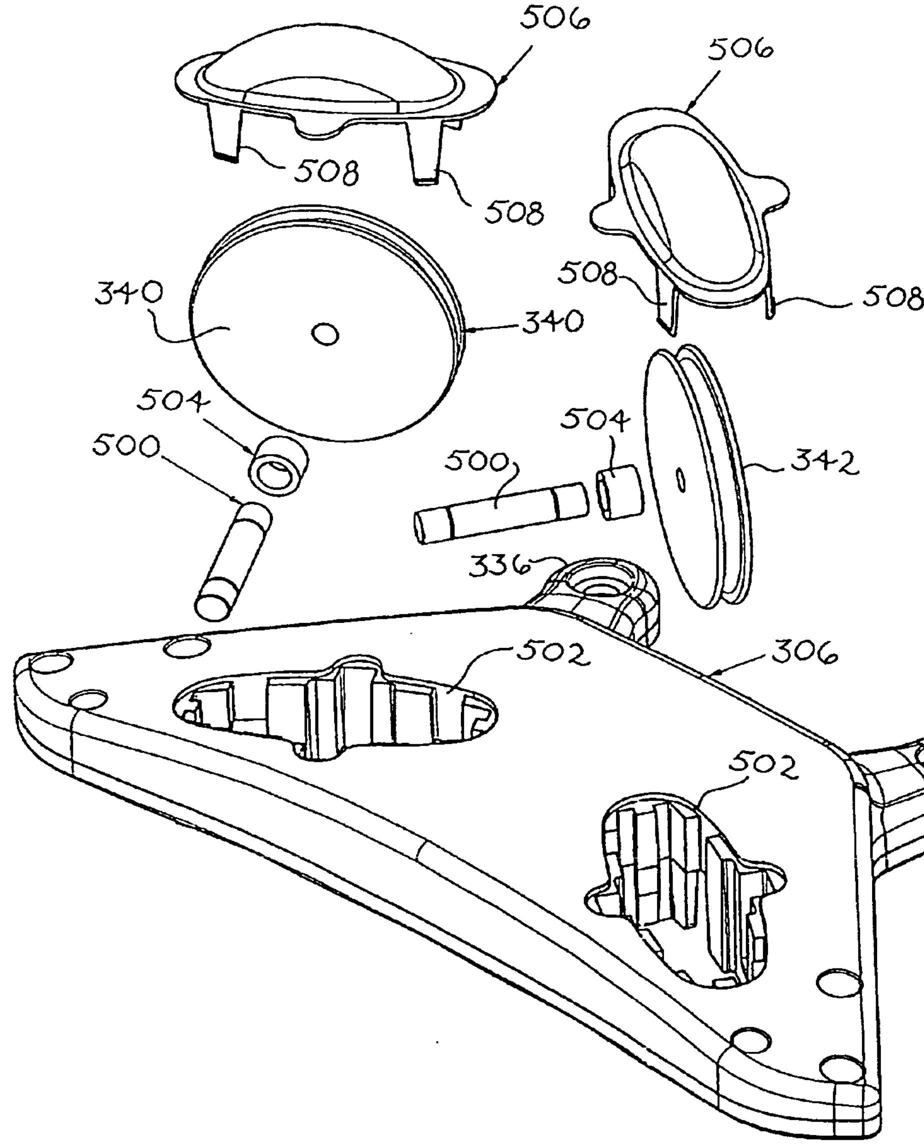
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Fig. 19

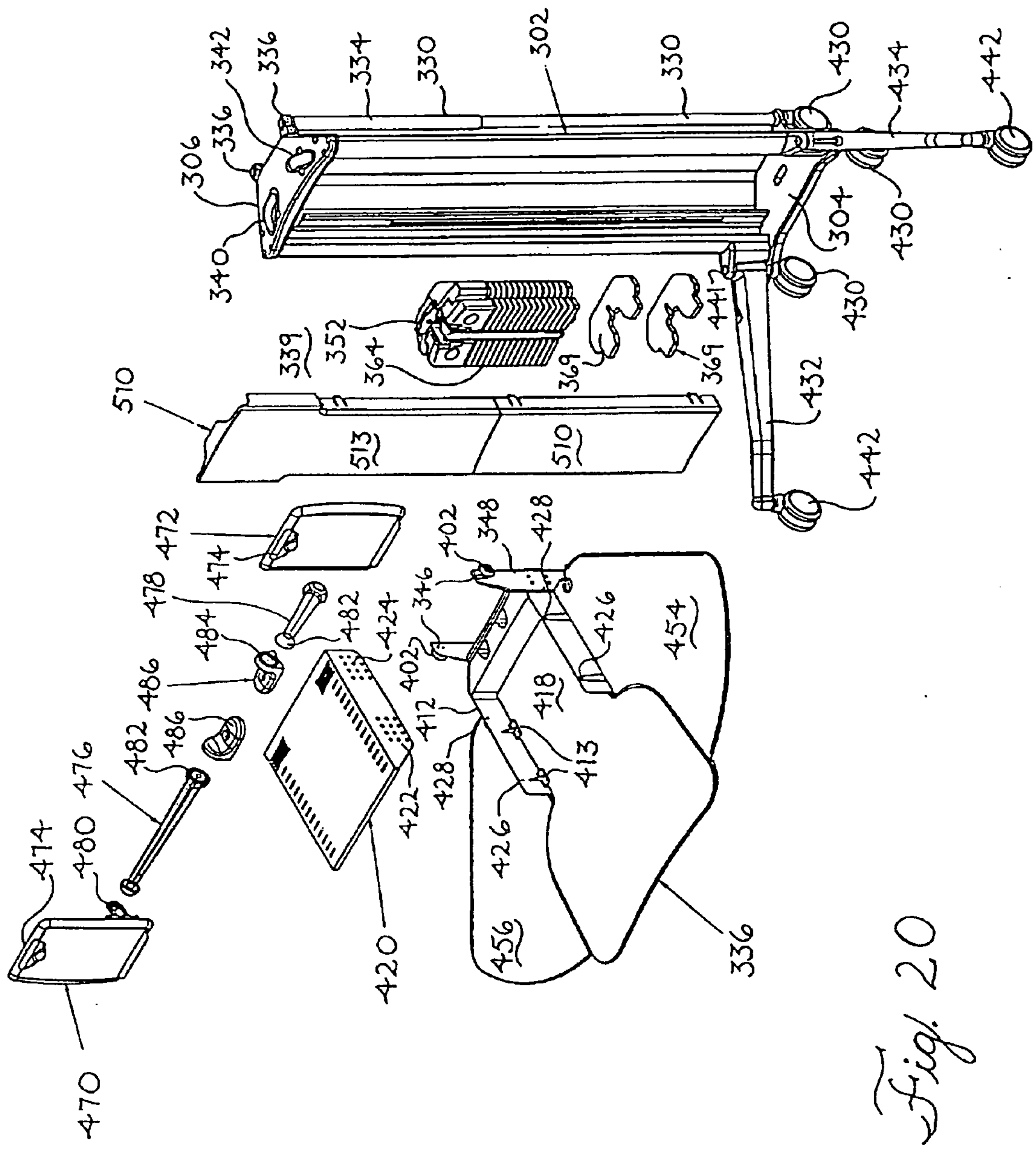
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Fig. 20

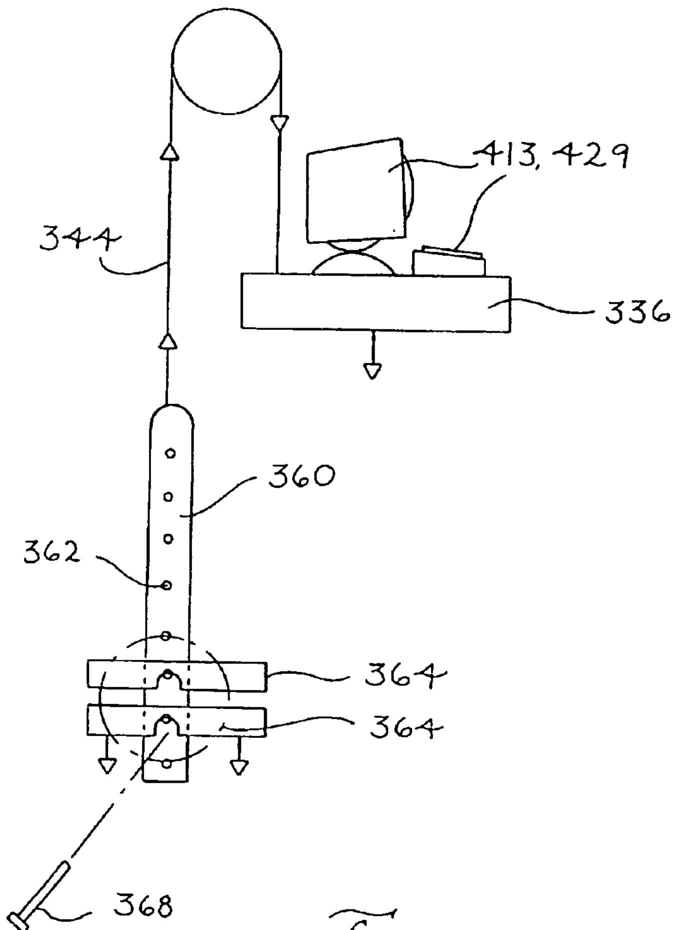
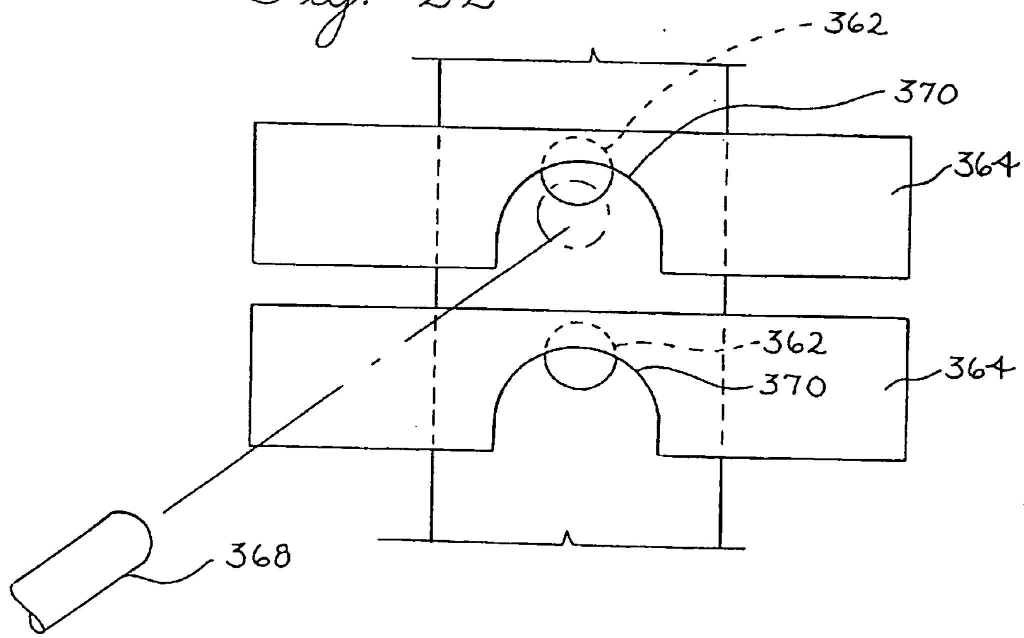


Fig. 21

Fig. 22



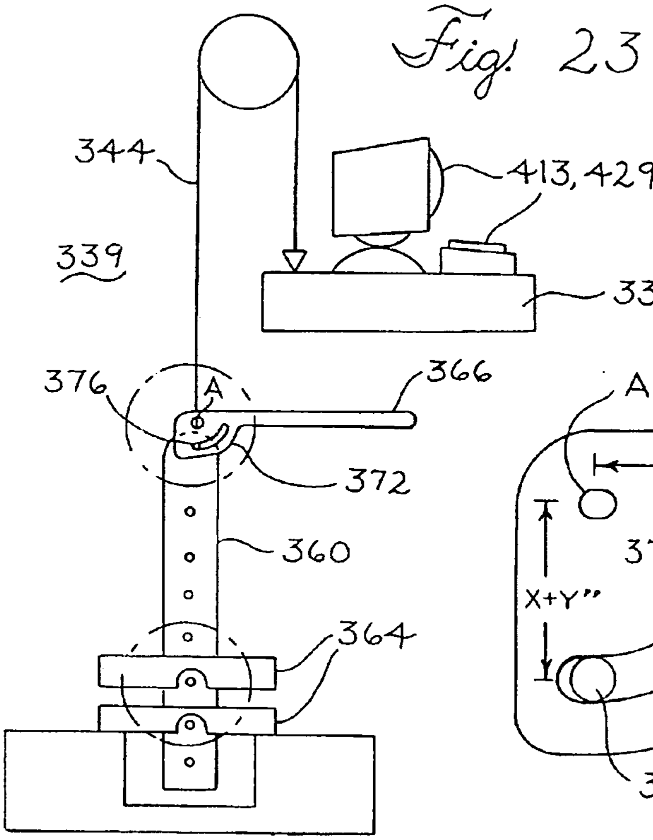


Fig. 23

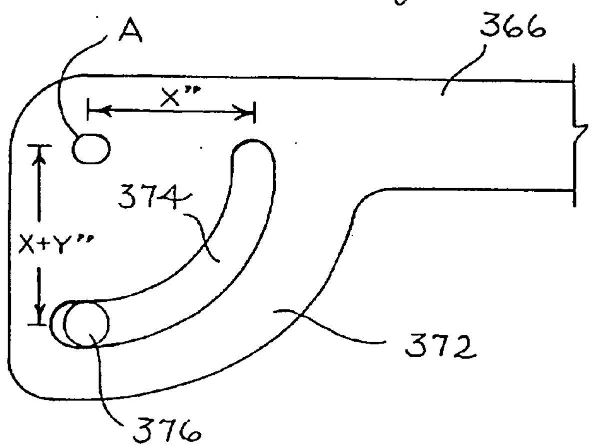


Fig. 24

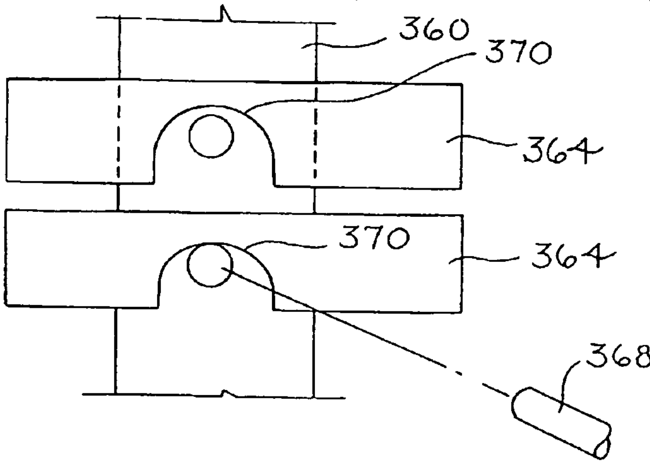
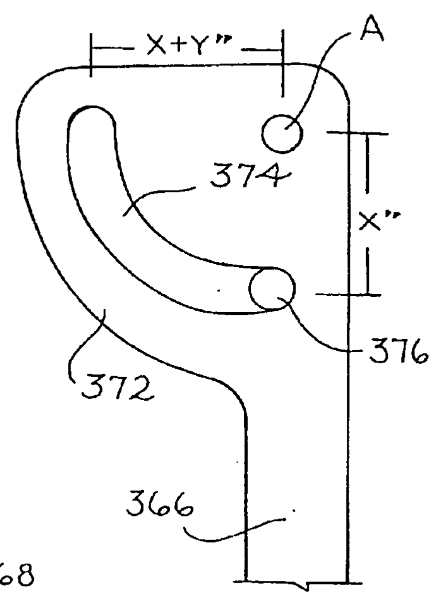


Fig. 25



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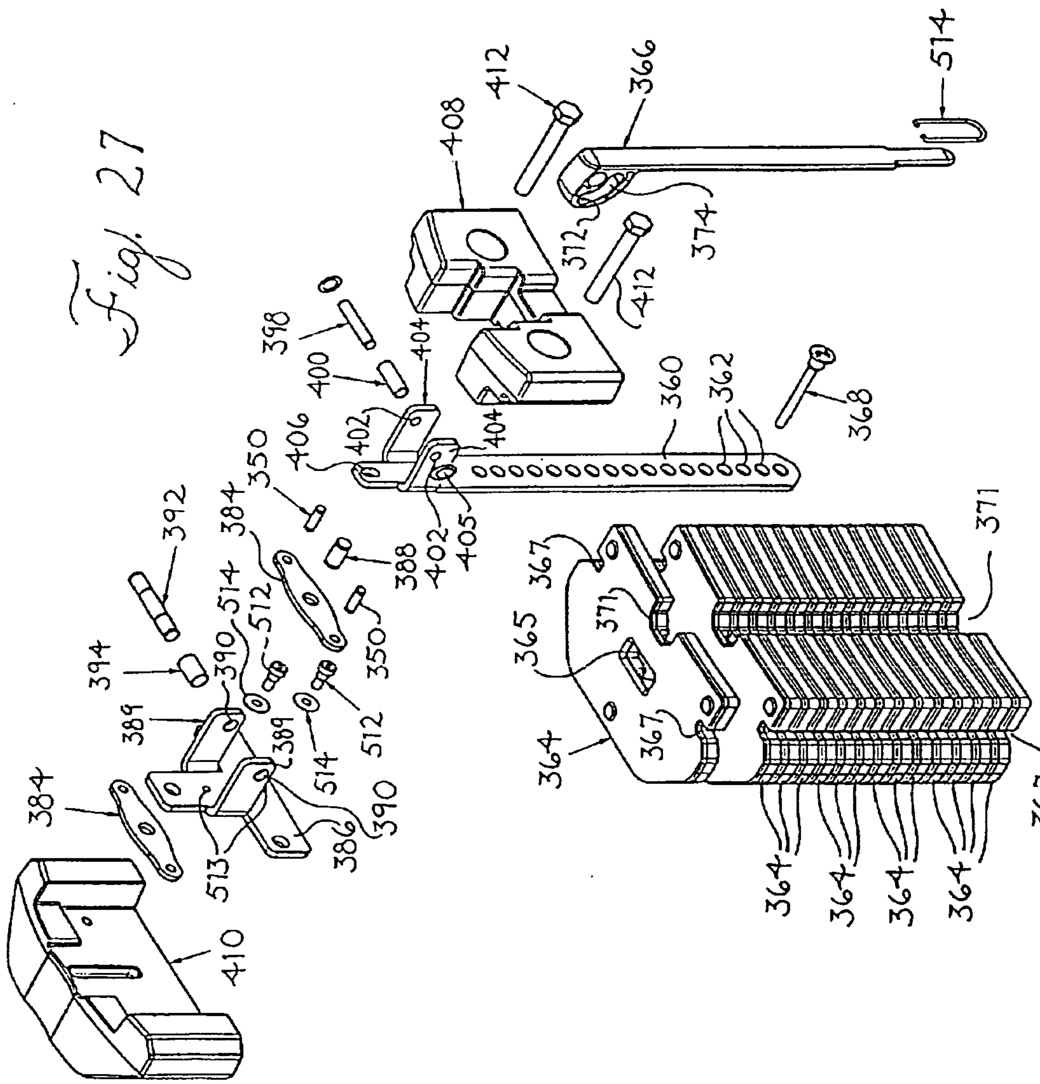
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Fig. 27

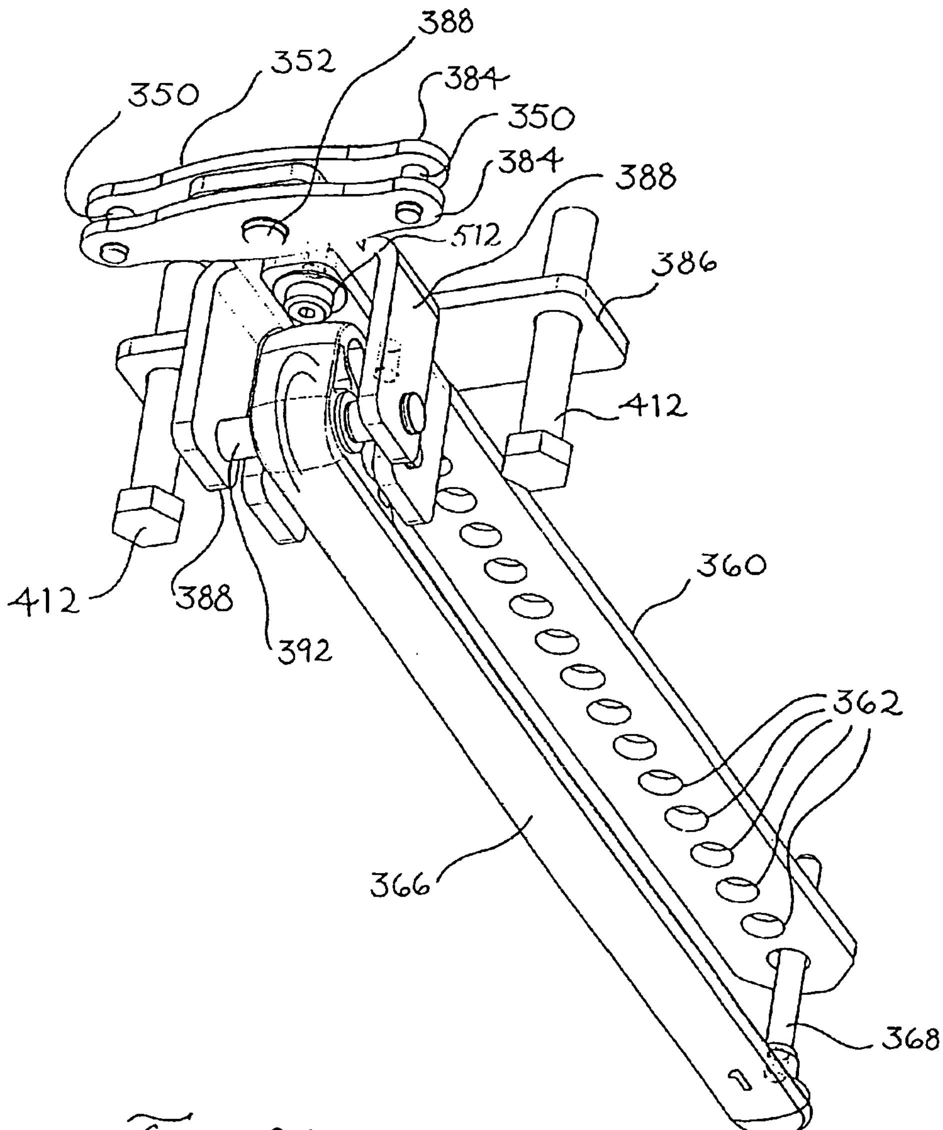

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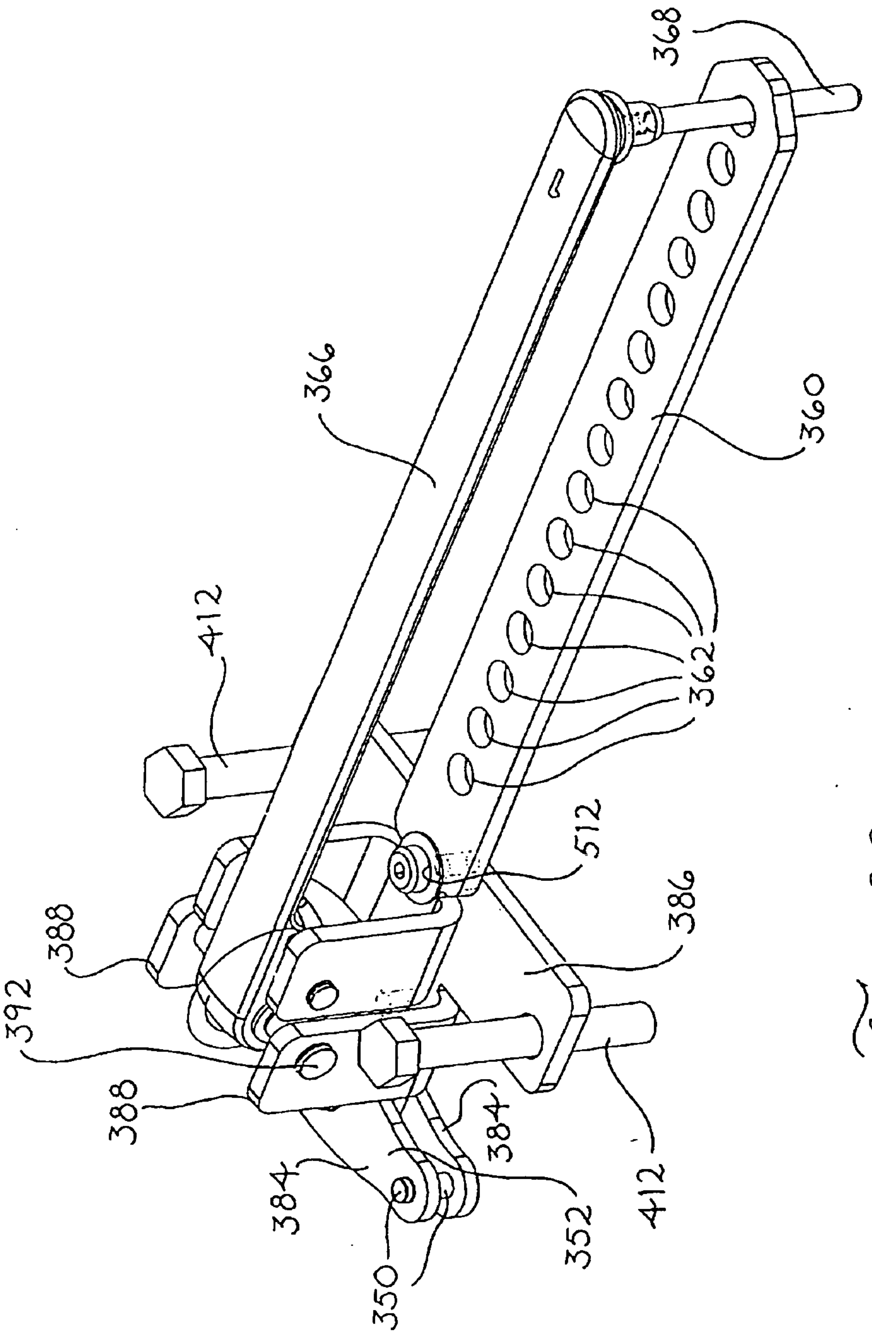
Fig. 28



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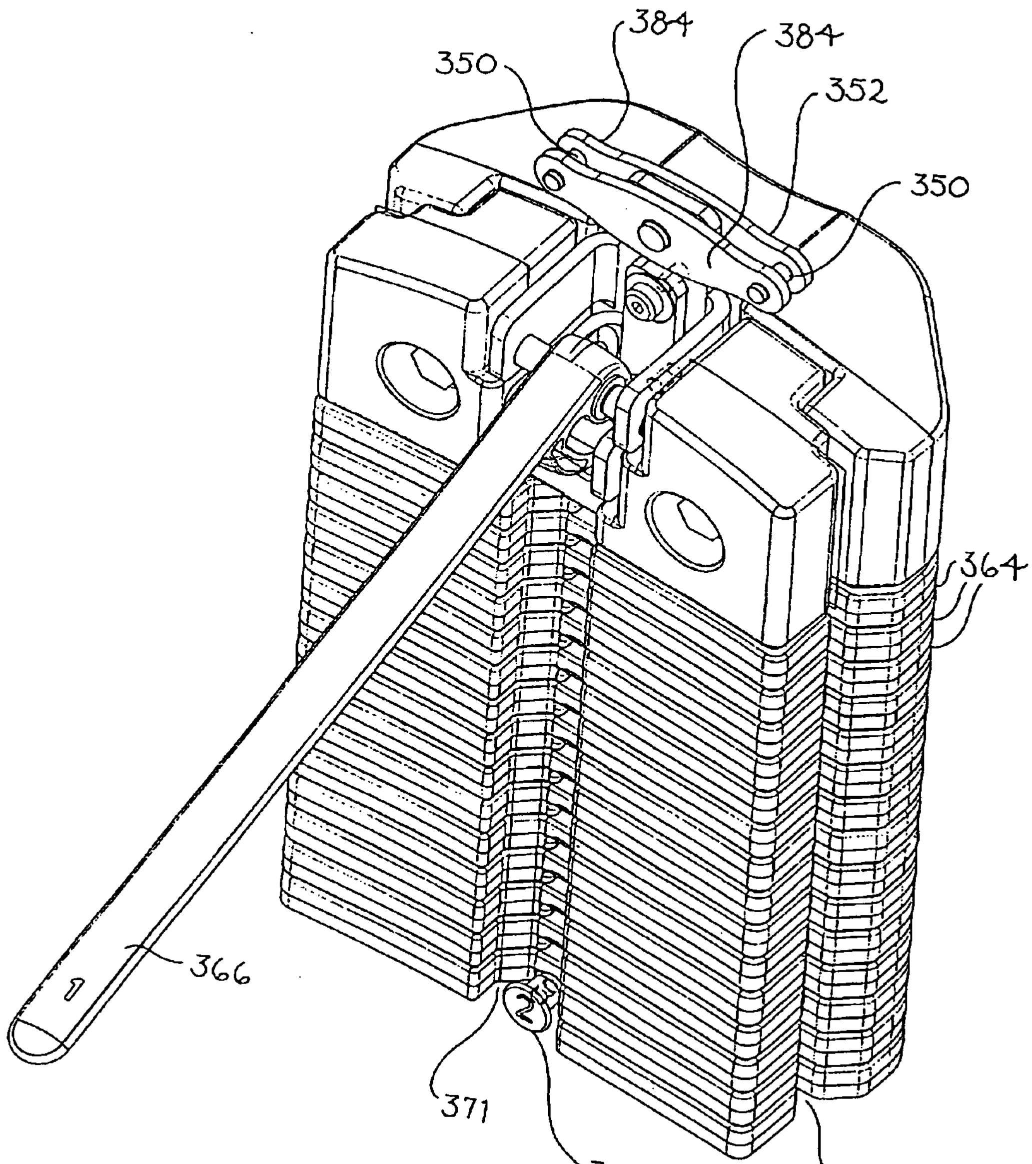

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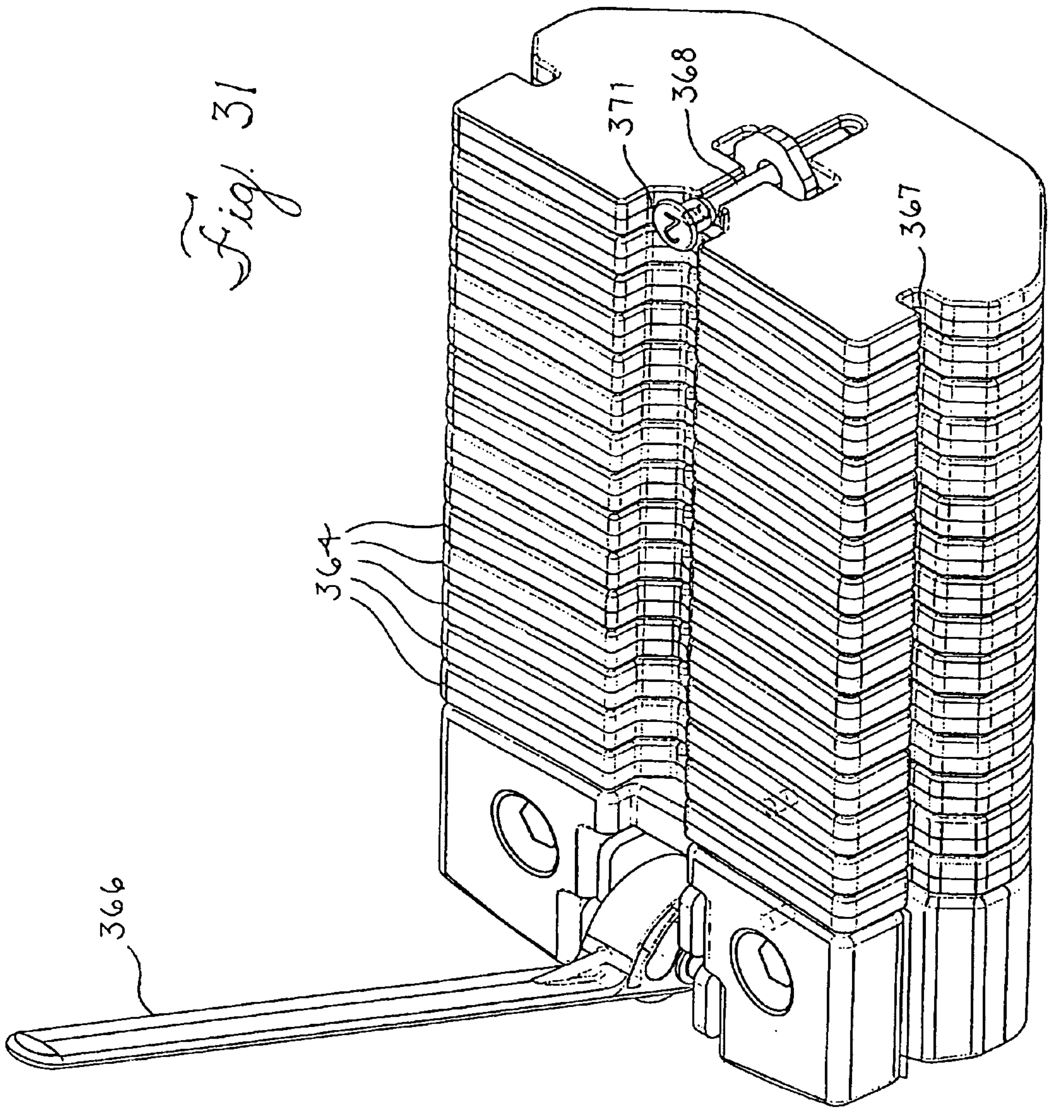

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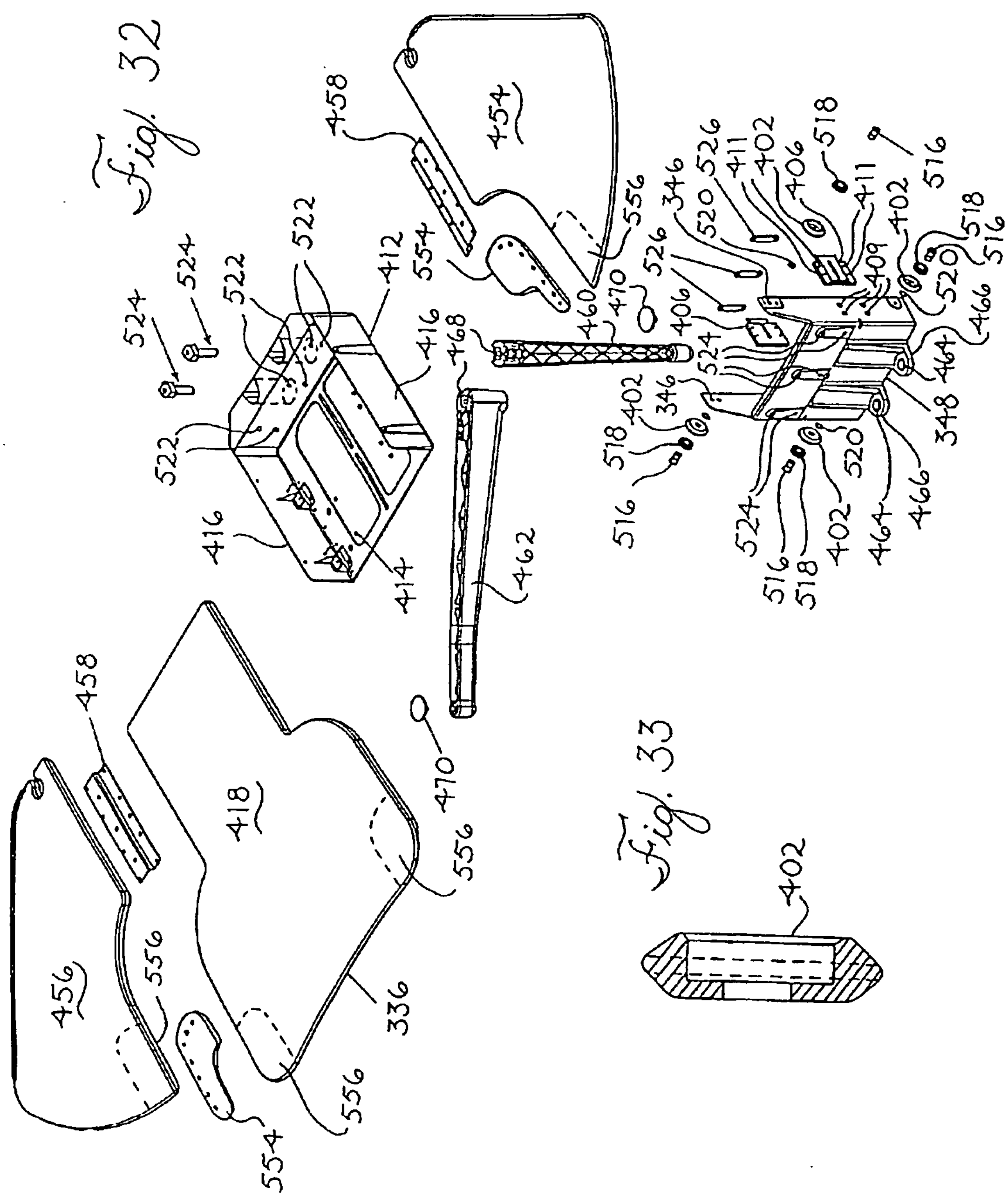

Fig. 32

Fig. 33

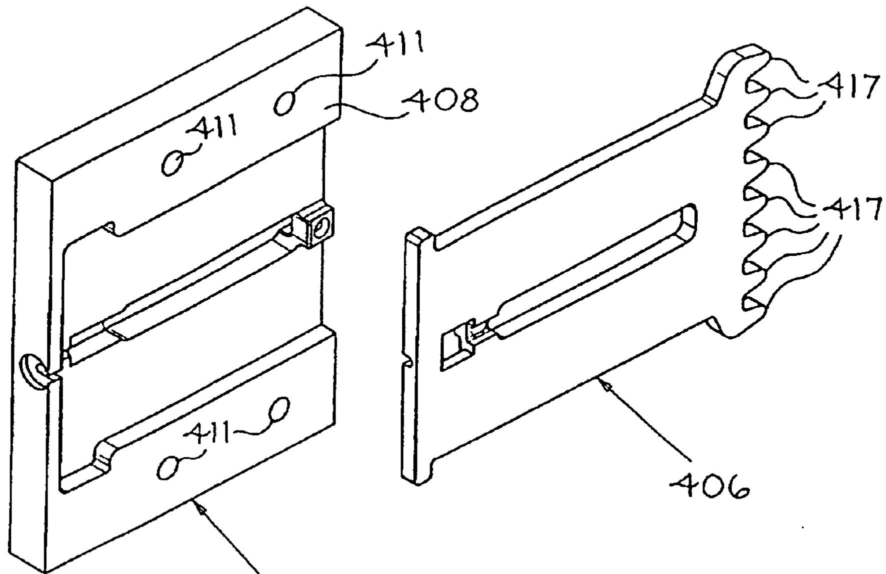
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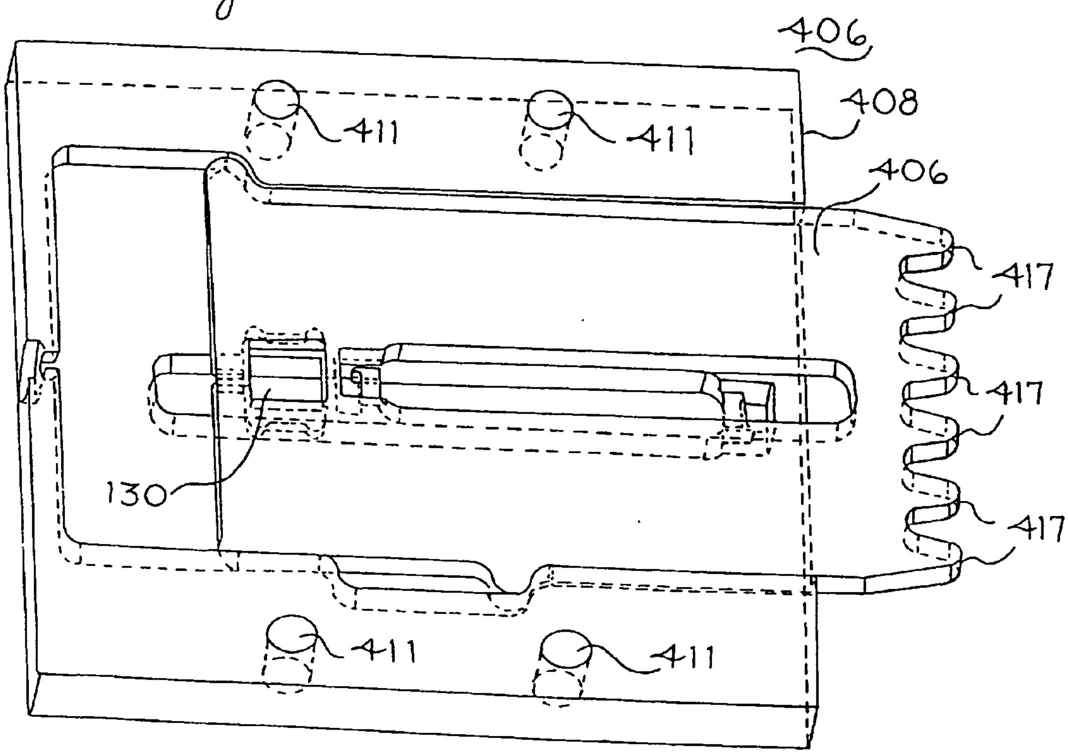
Fig. 34

Fig. 35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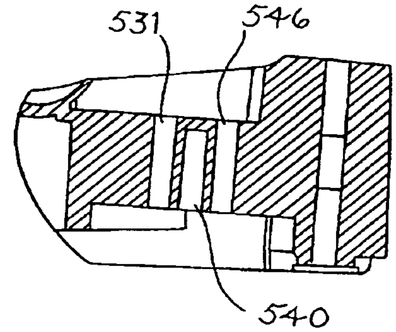
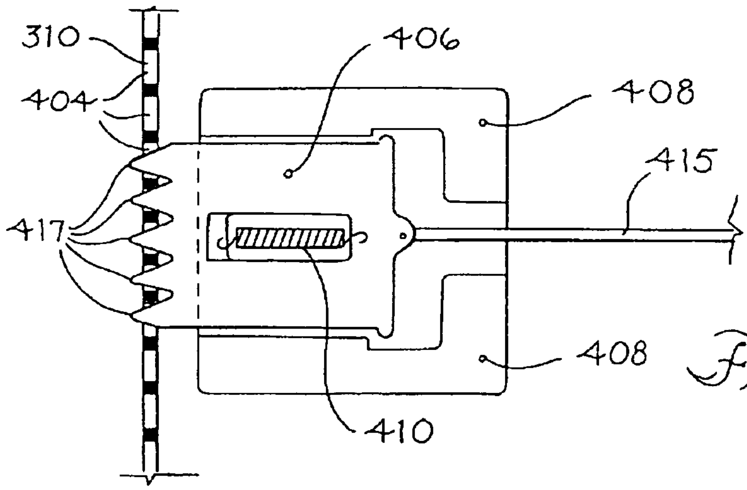


Fig. 44B



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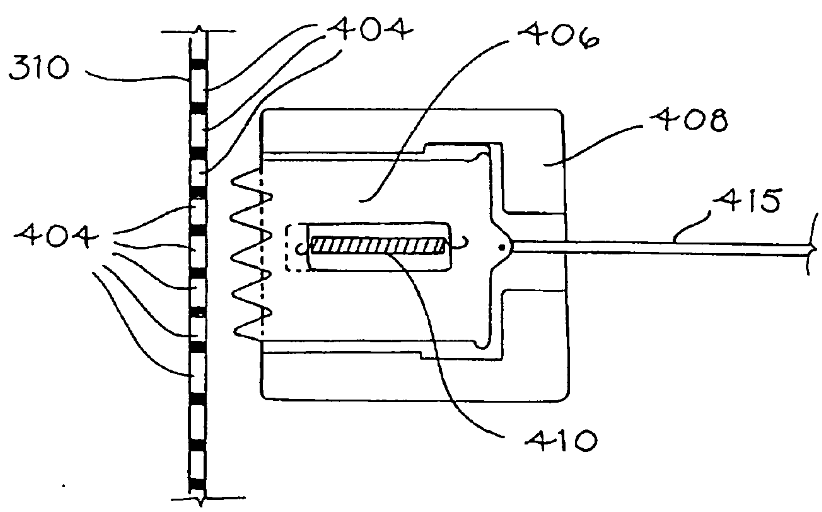
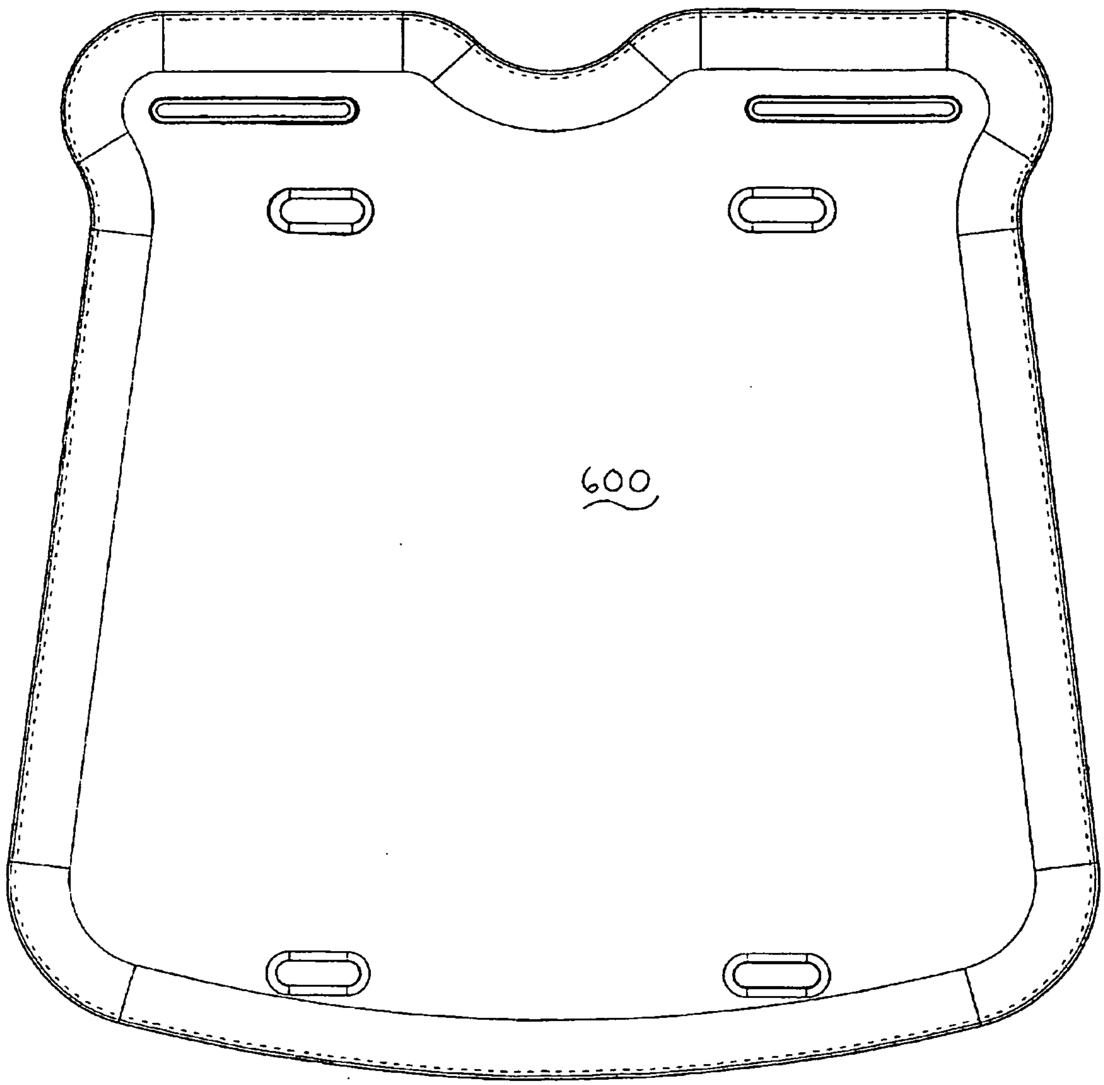


Fig. 37



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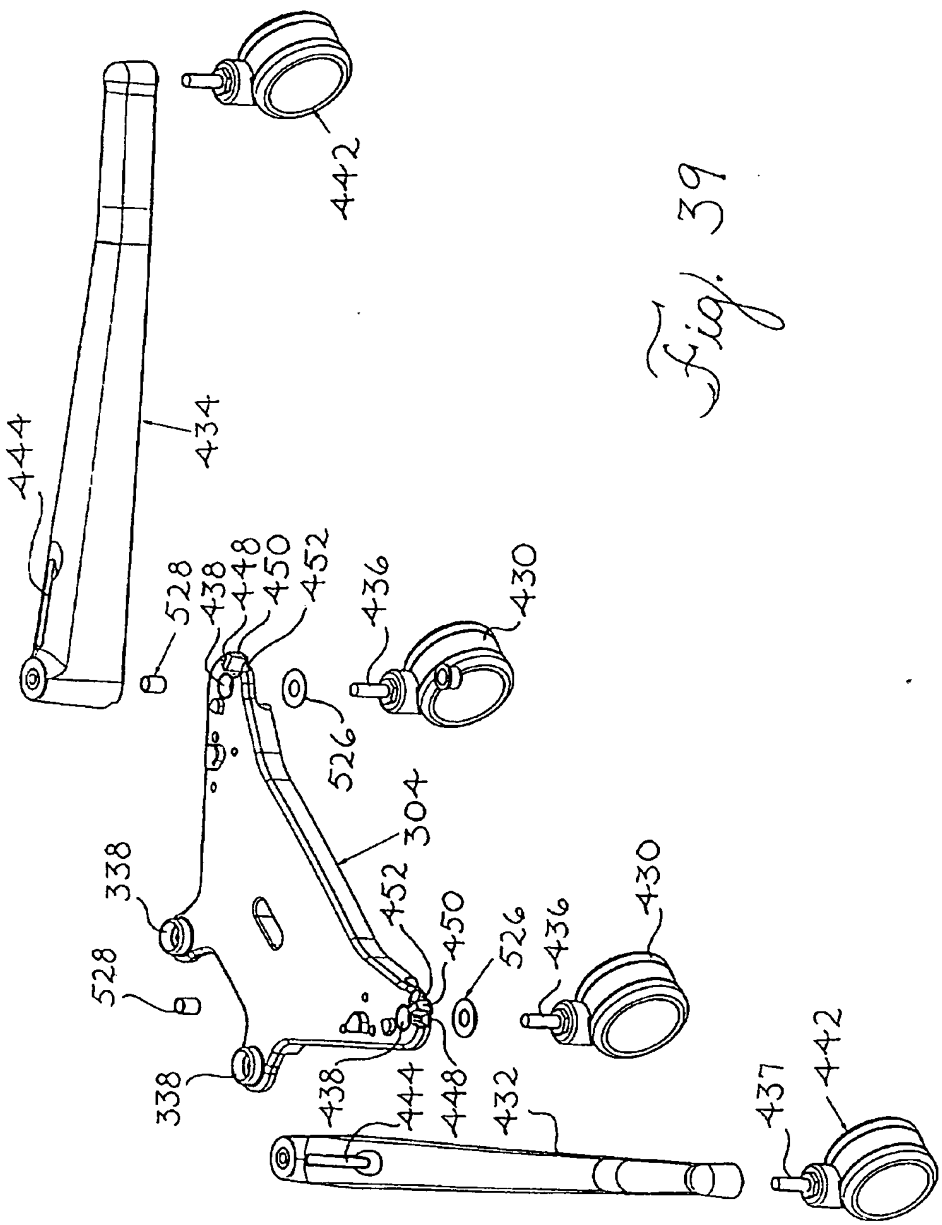
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Fig. 39

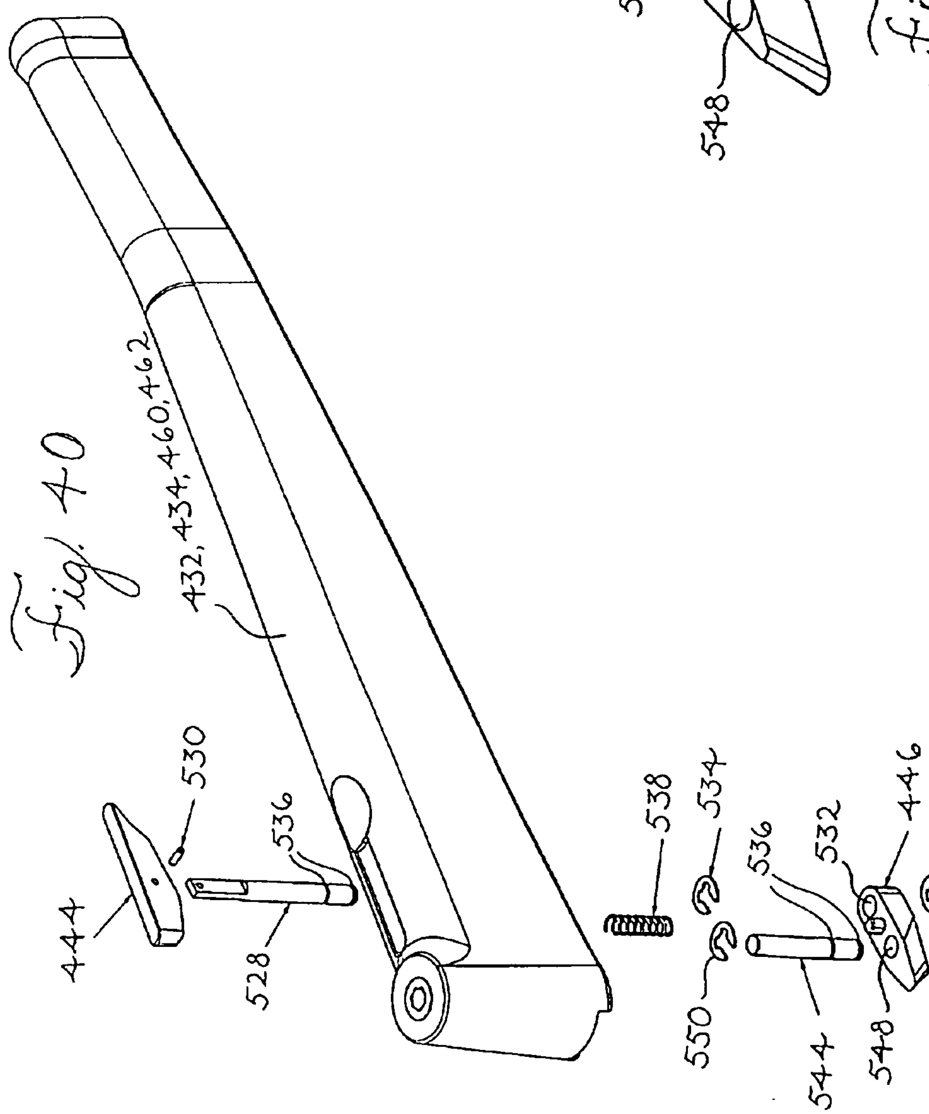
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Fig. 40

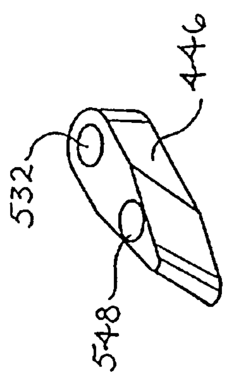
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Fig. 41

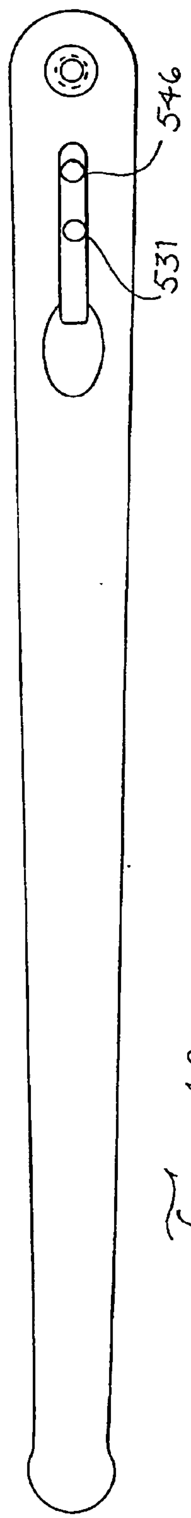
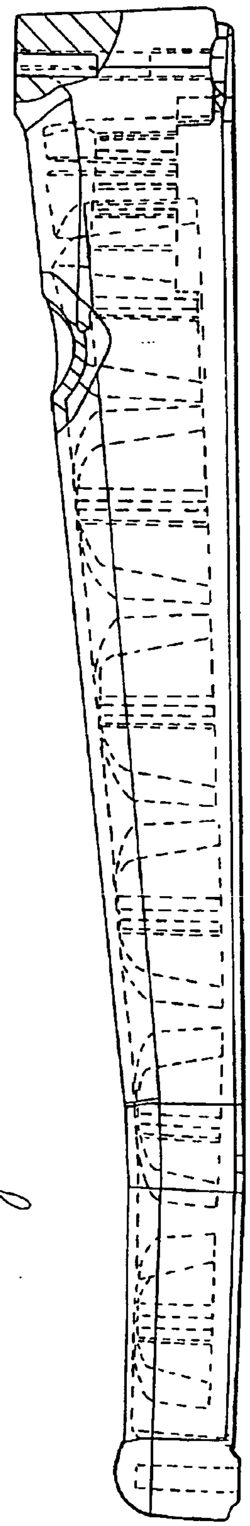


Fig. 42



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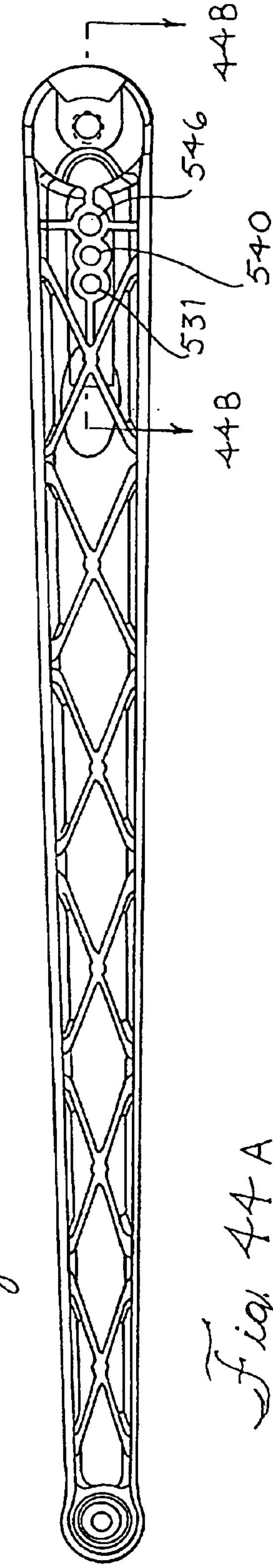
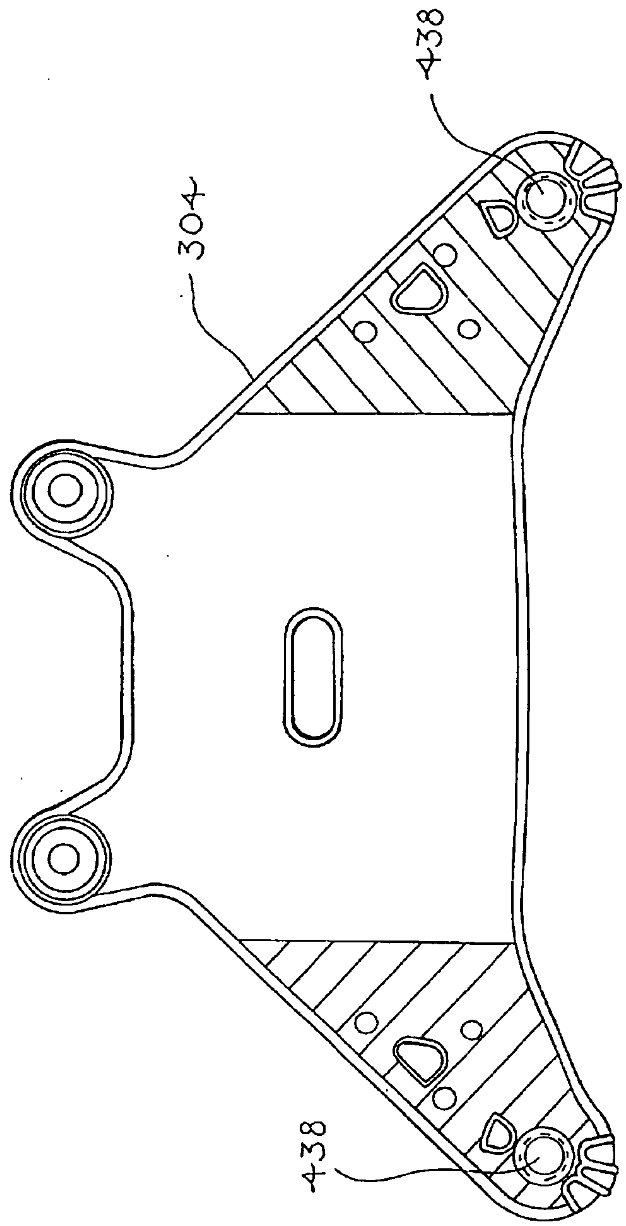


Fig. 44A



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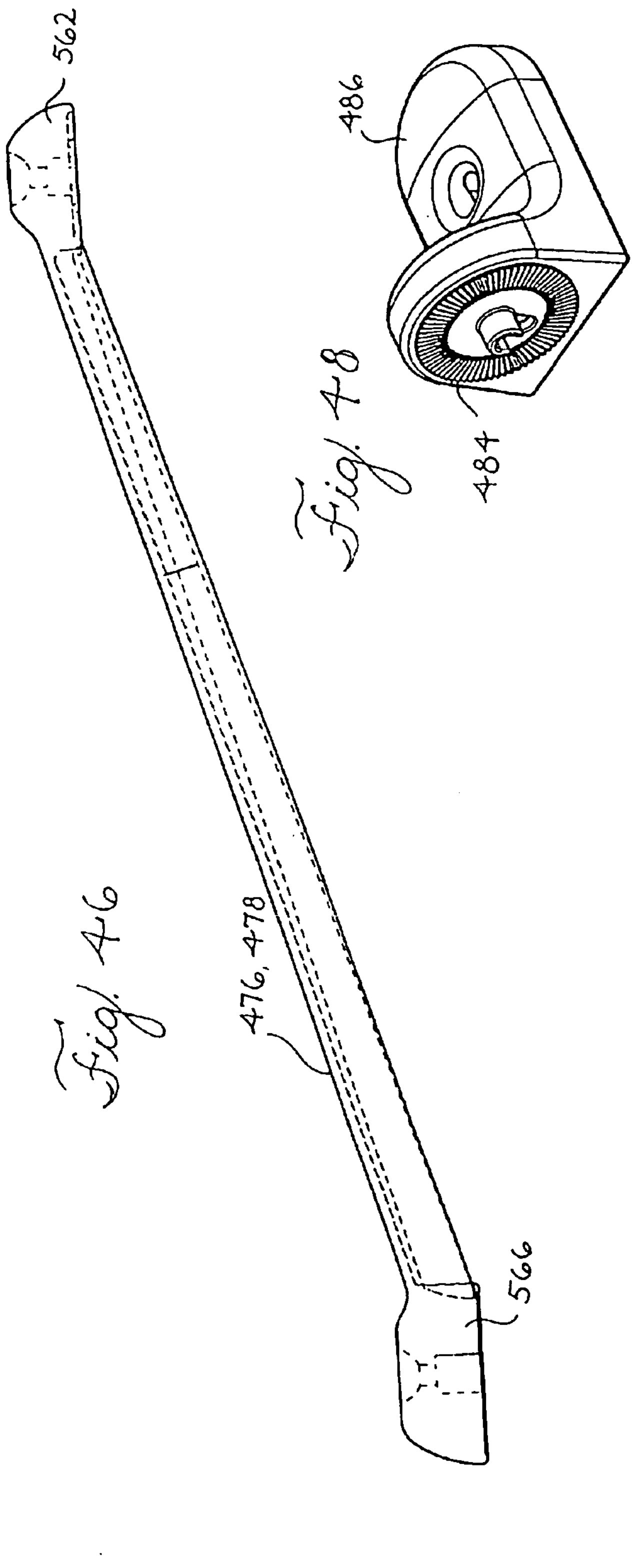
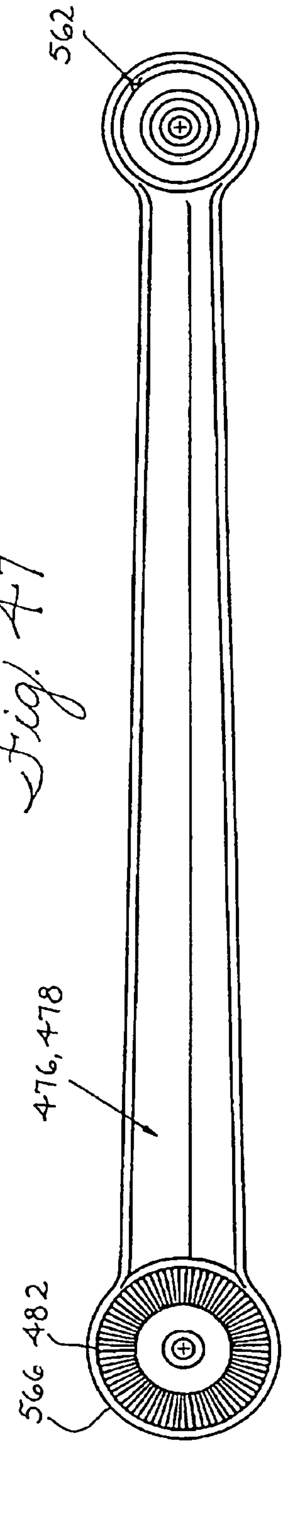


Fig. 46

Fig. 48



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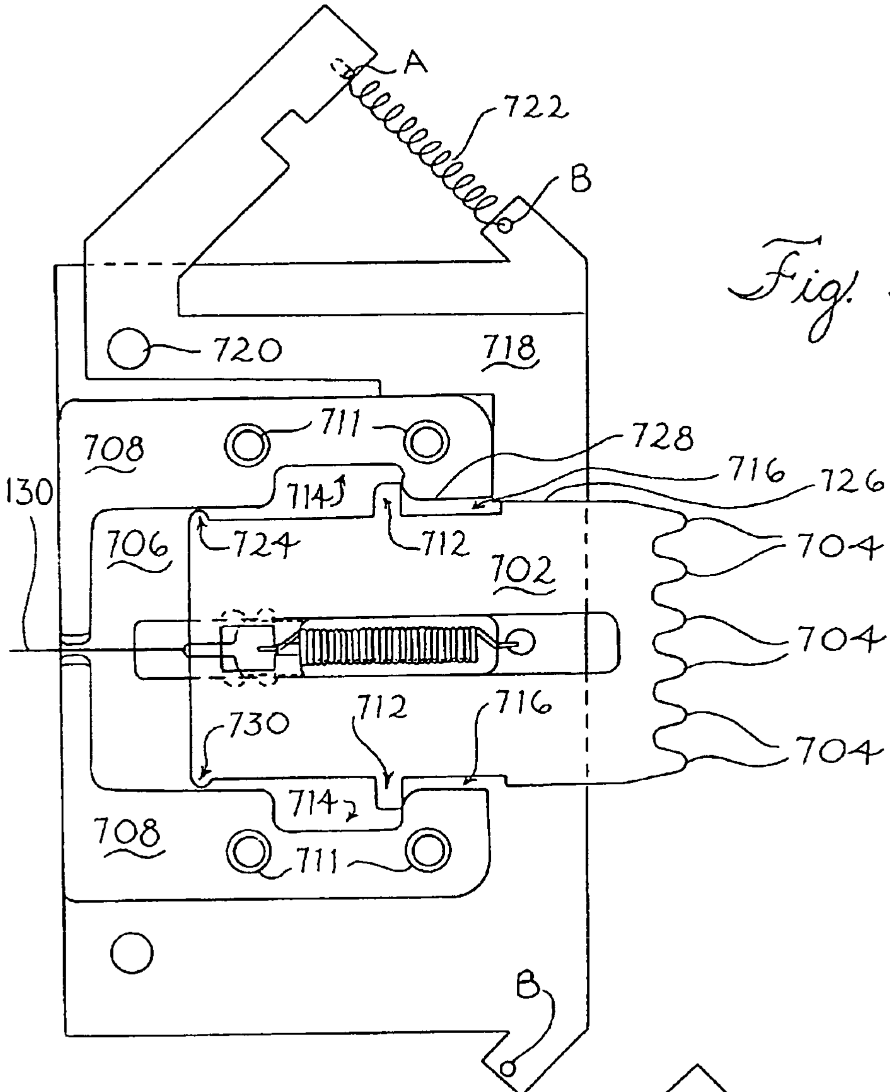
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Fig. 50

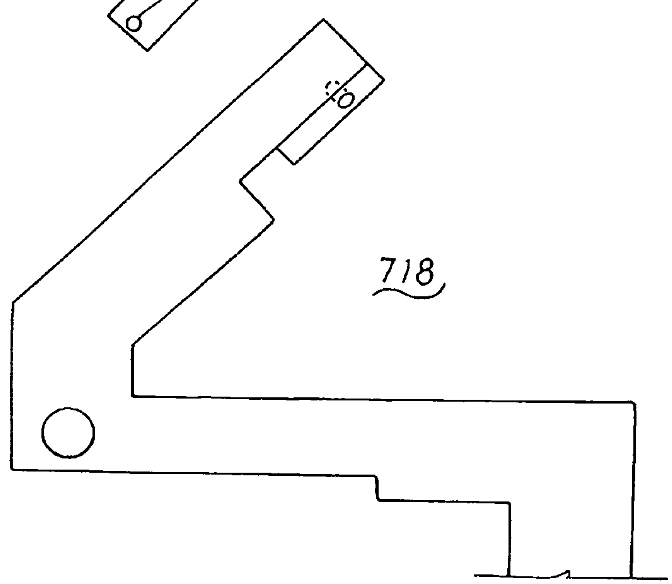
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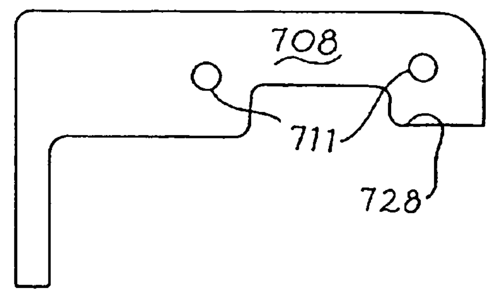
Fig. 53

Fig. 51



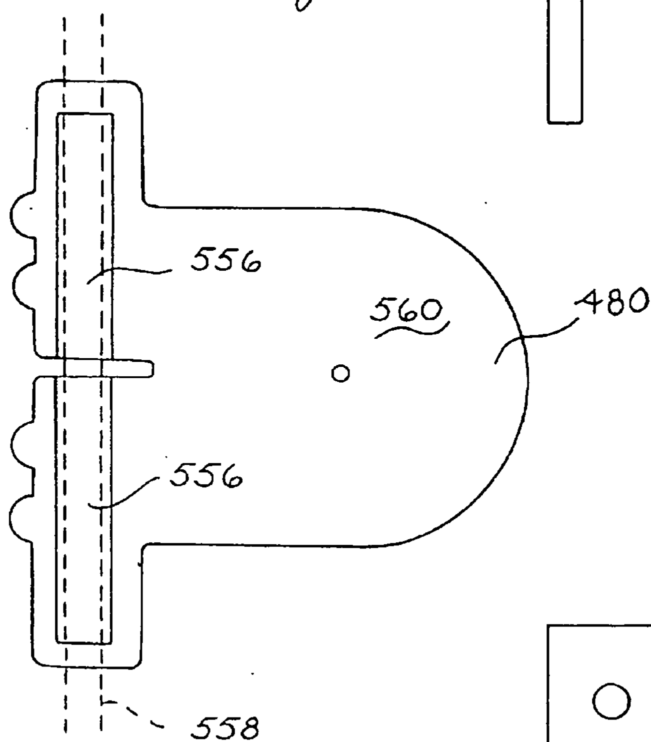
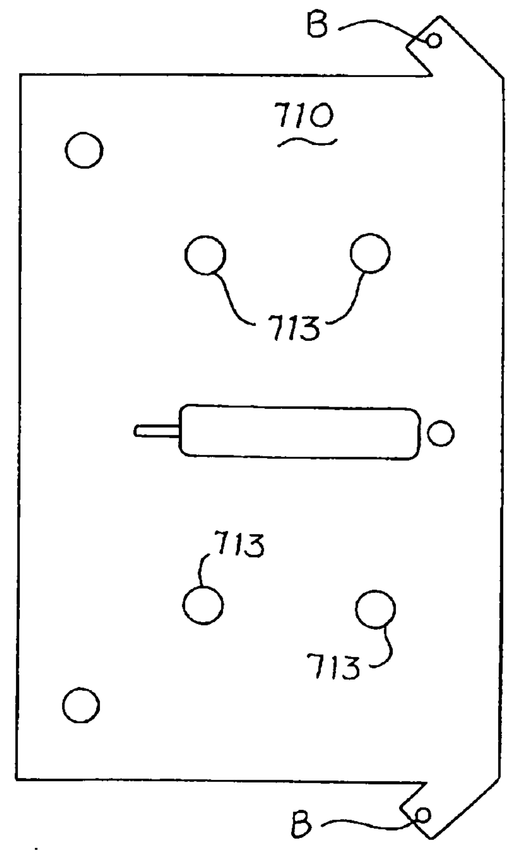


Fig. 49

Fig. 52



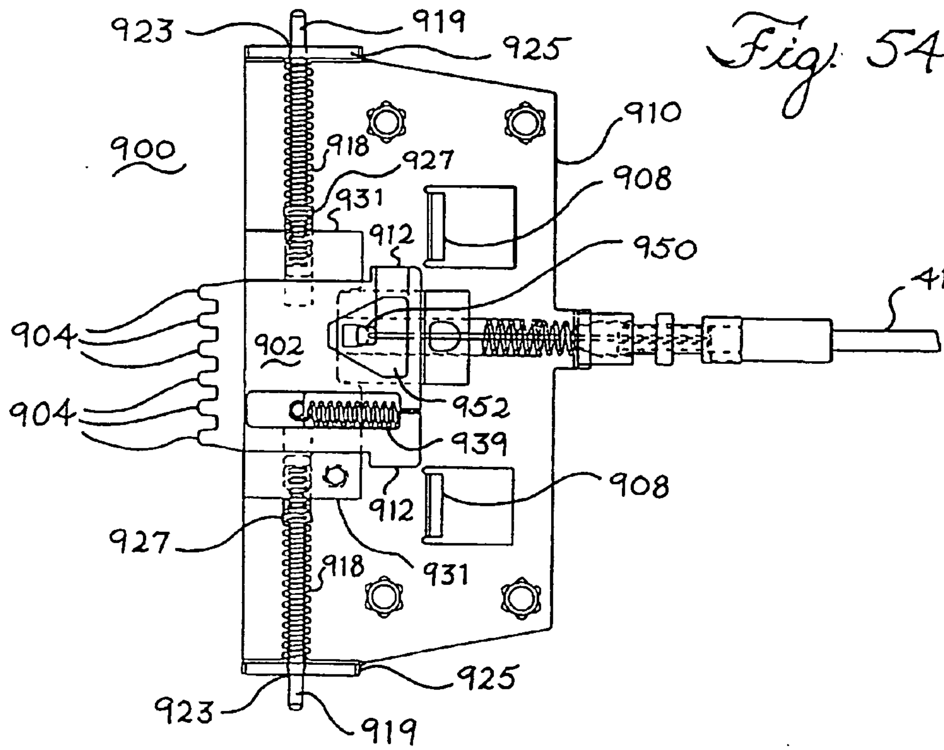


Fig. 54

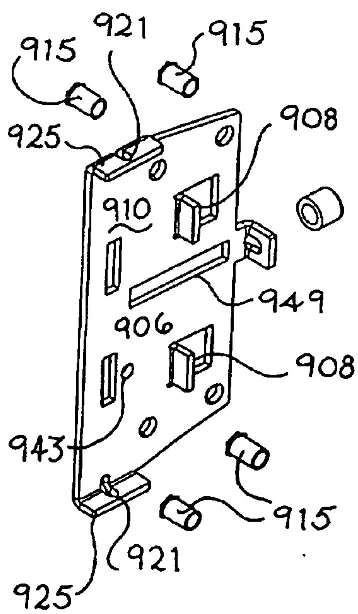
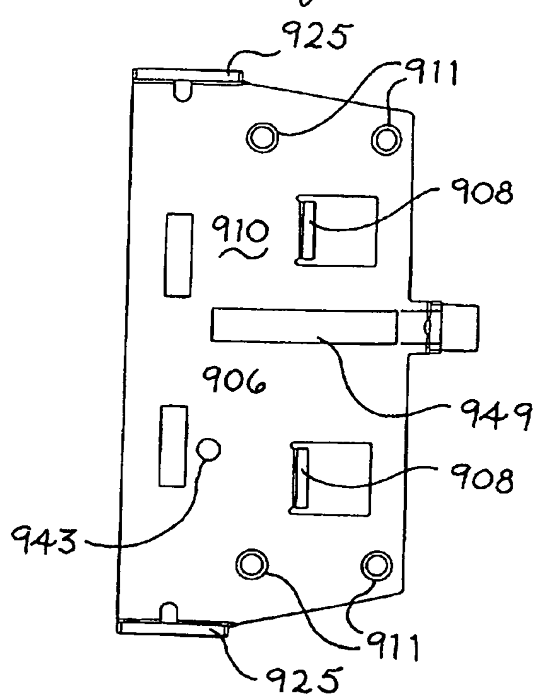


Fig. 55

Fig. 56



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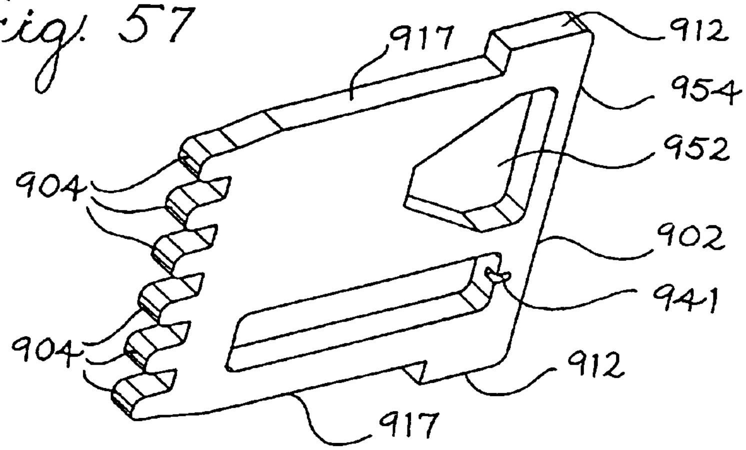

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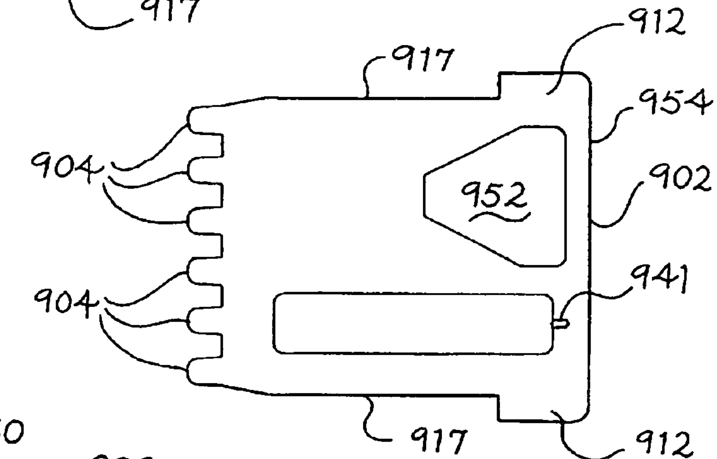

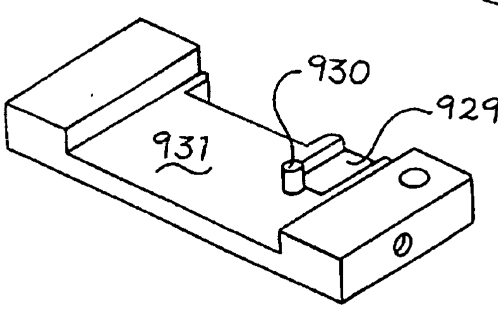

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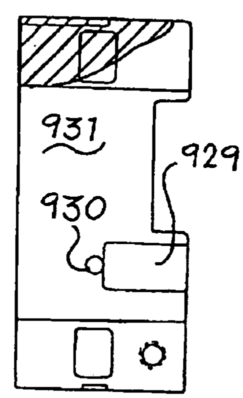

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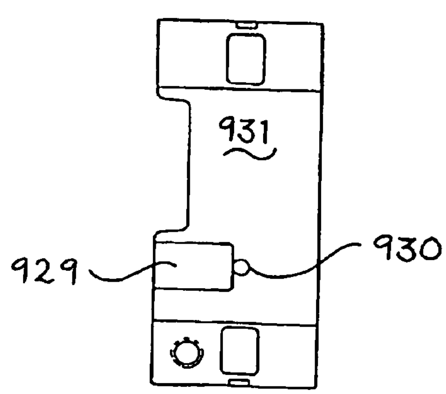
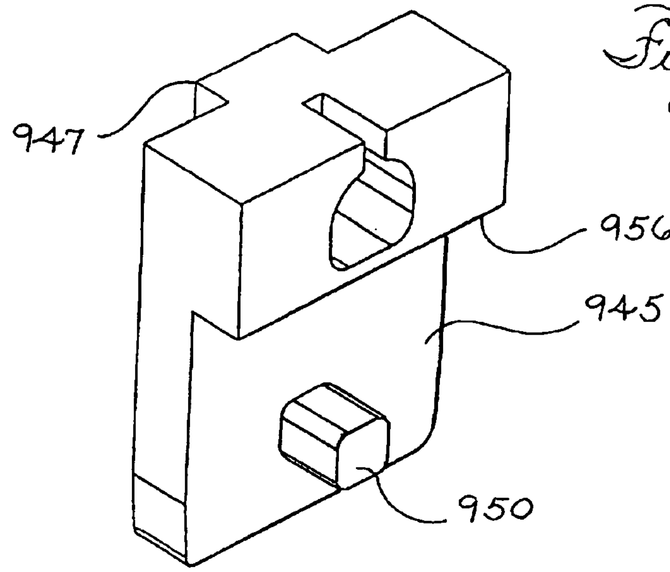


Fig. 61

Fig. 62



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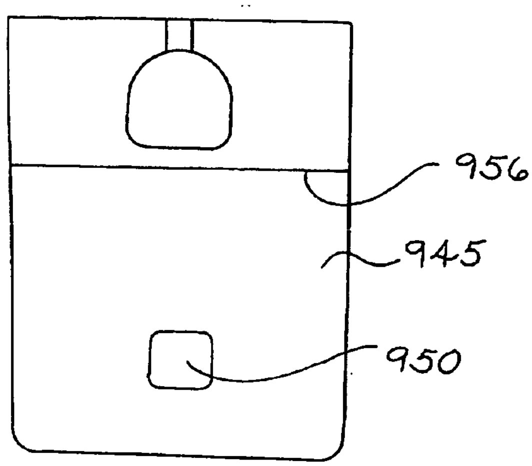


Fig. 64

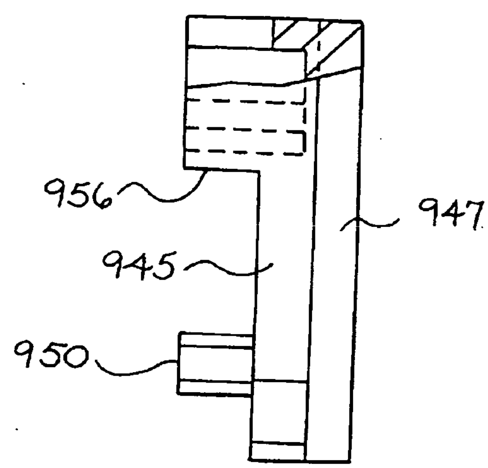
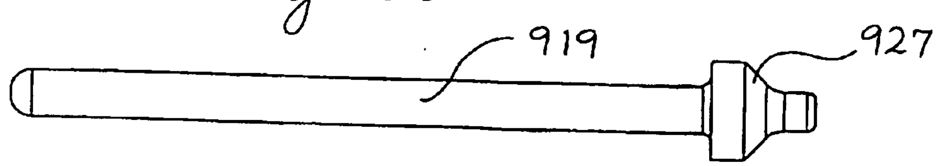
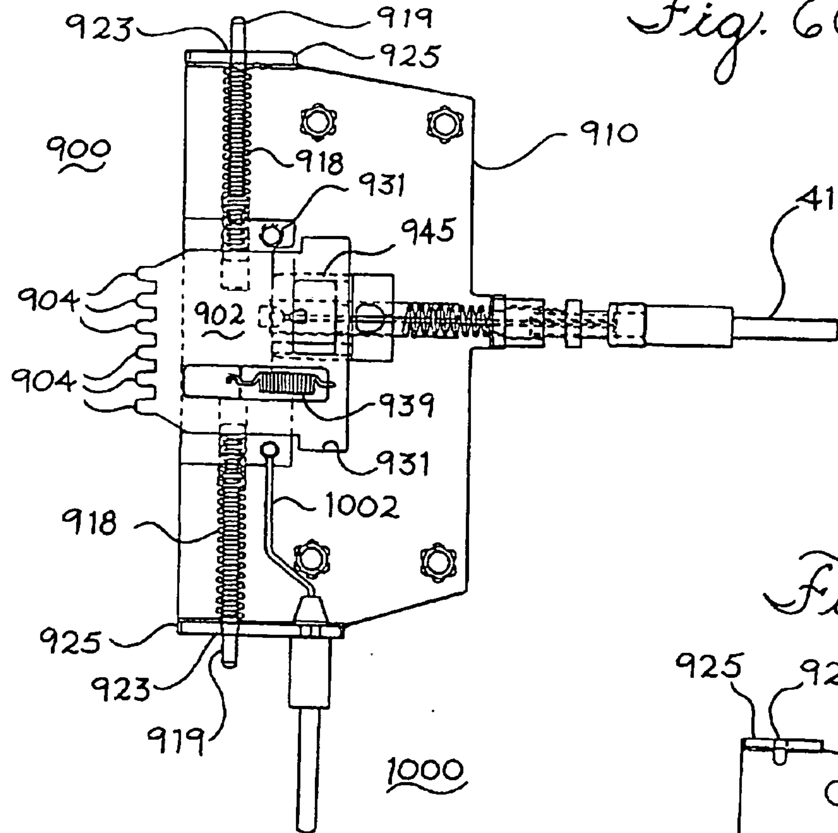


Fig. 65





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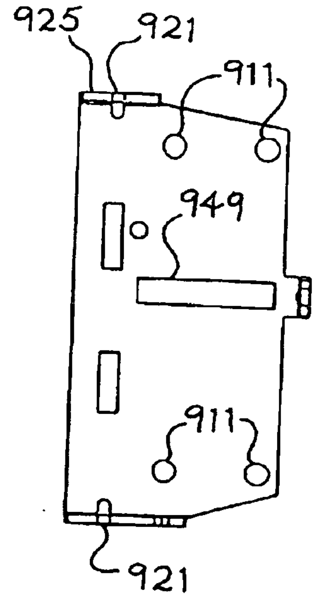

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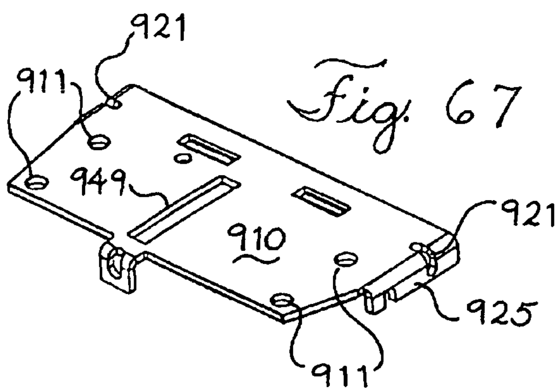

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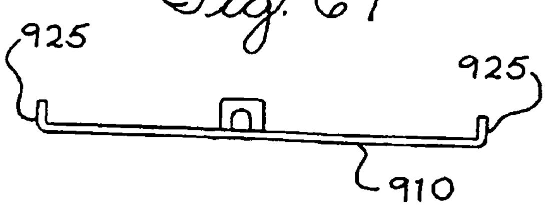

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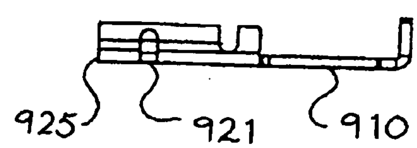
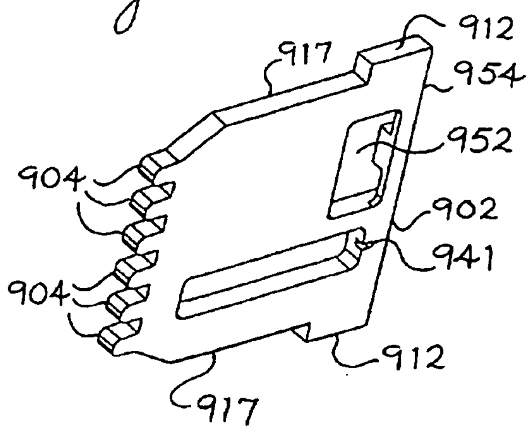


Fig. 70

Fig. 71



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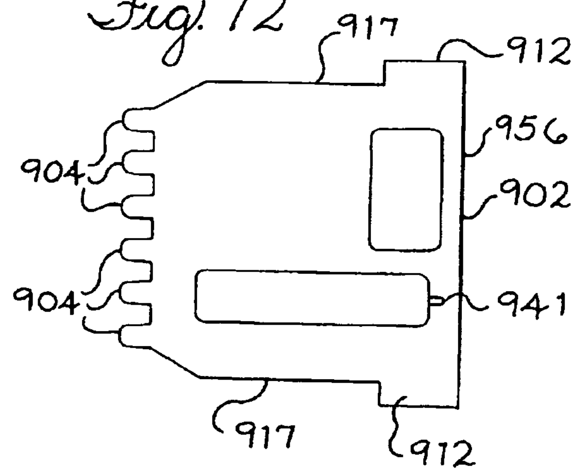

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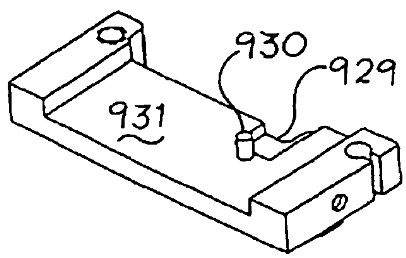
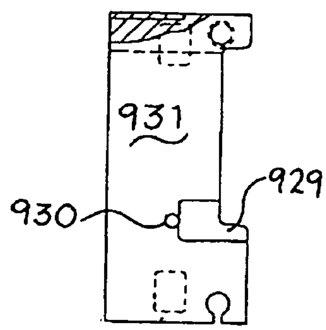


Fig. 74



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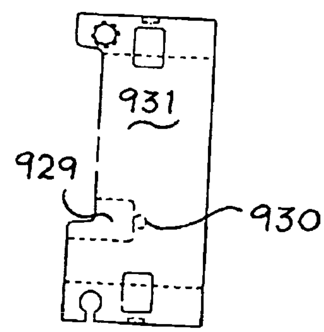

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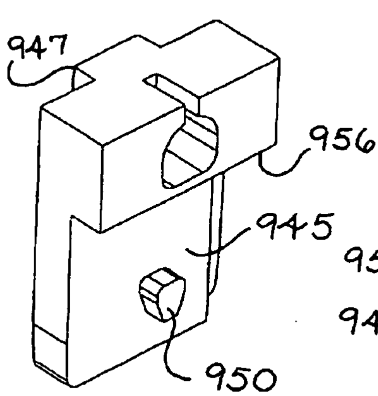

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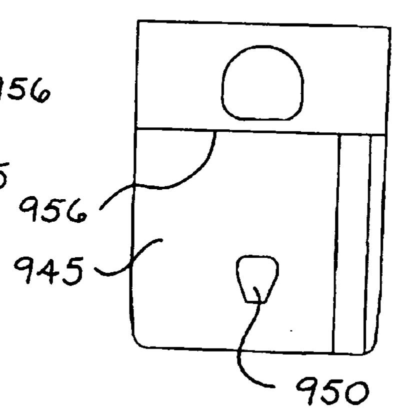

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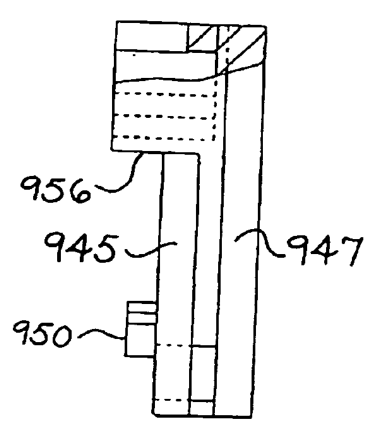

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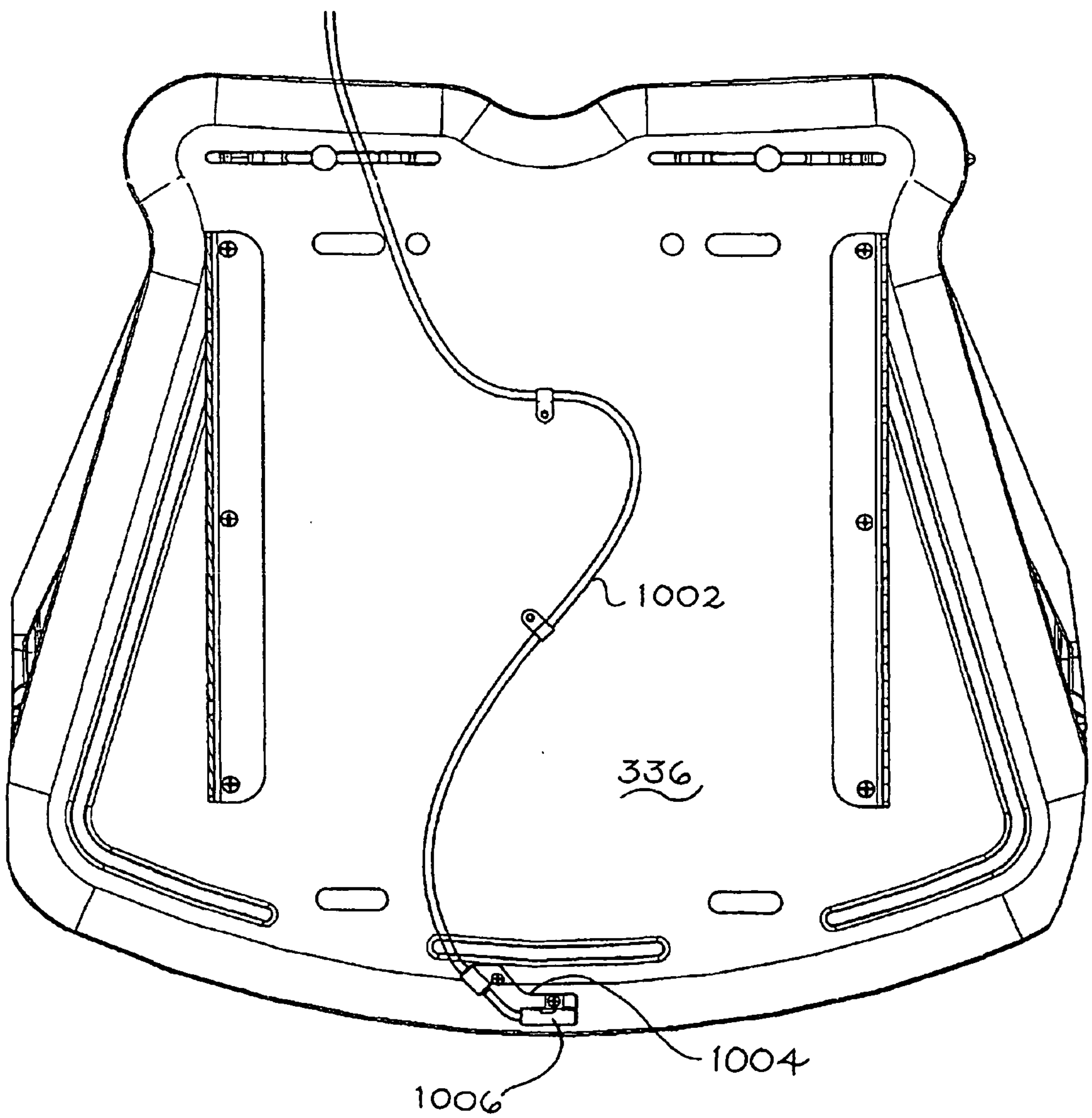

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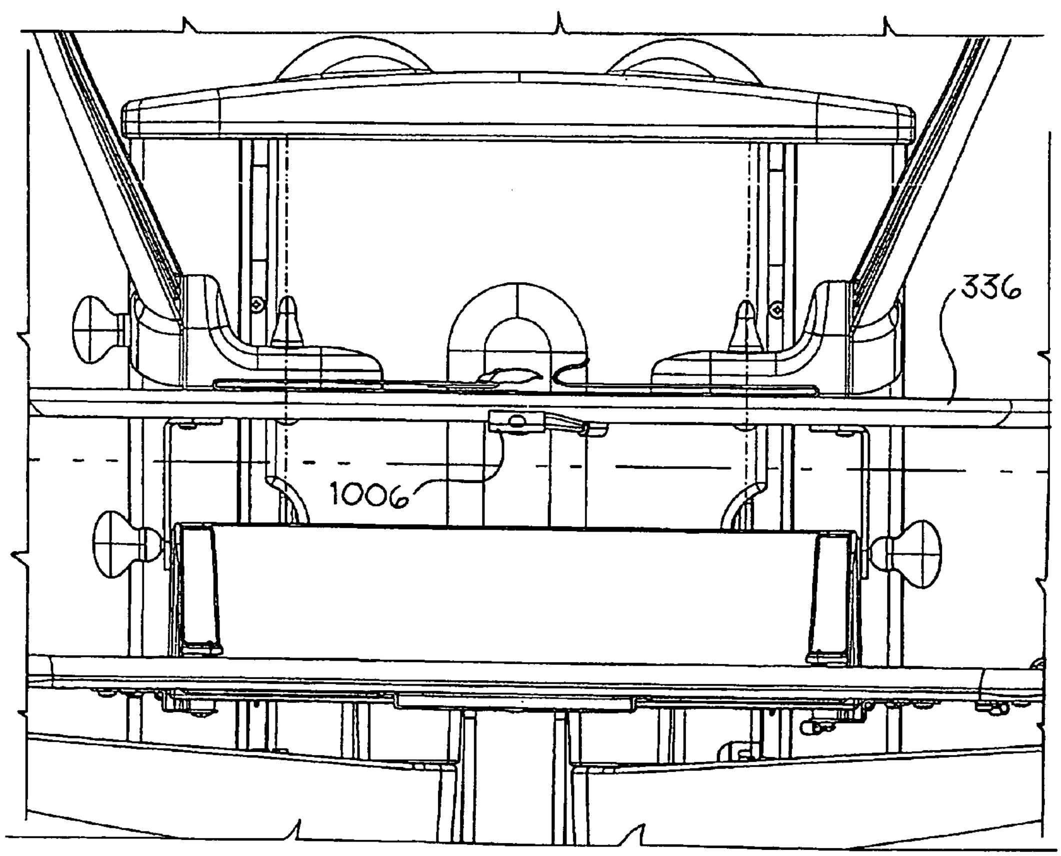

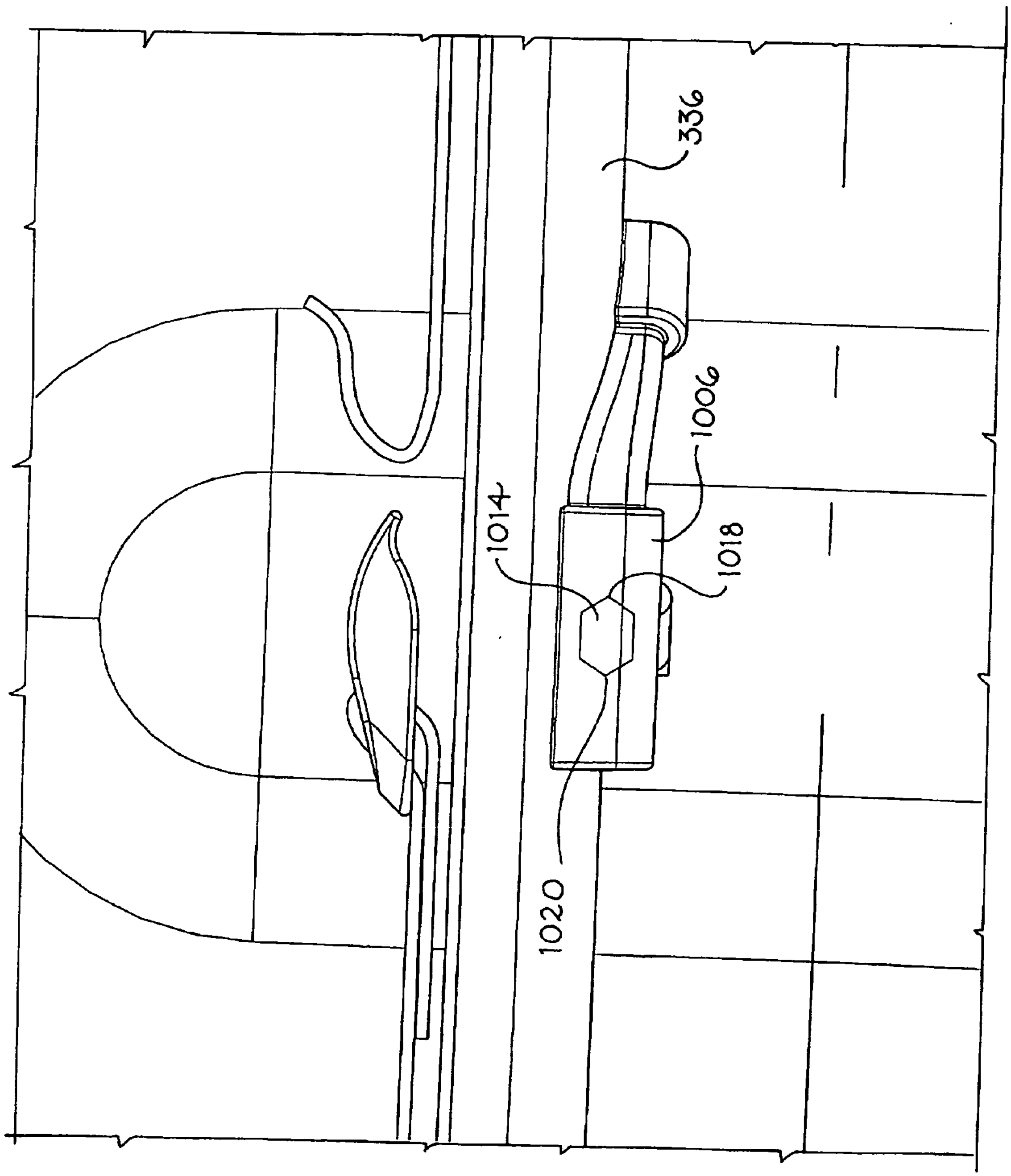

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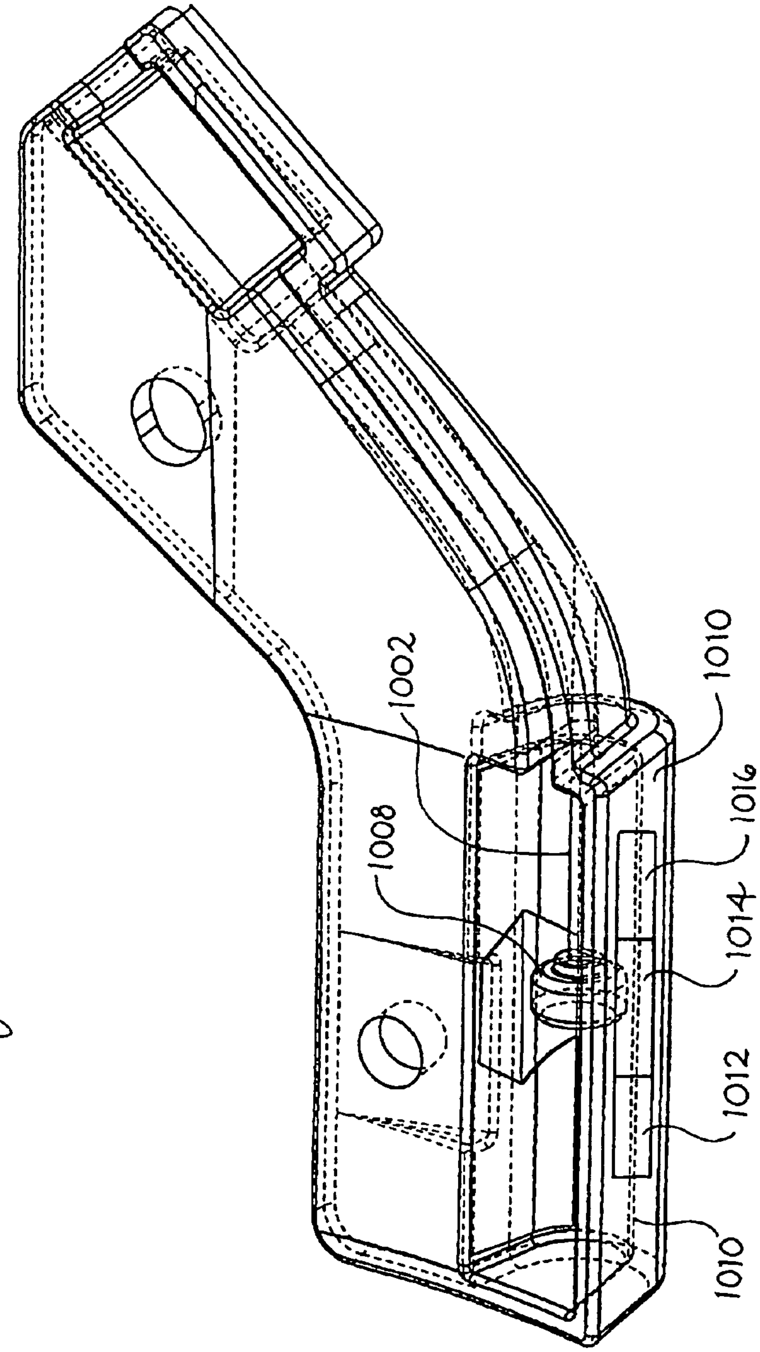

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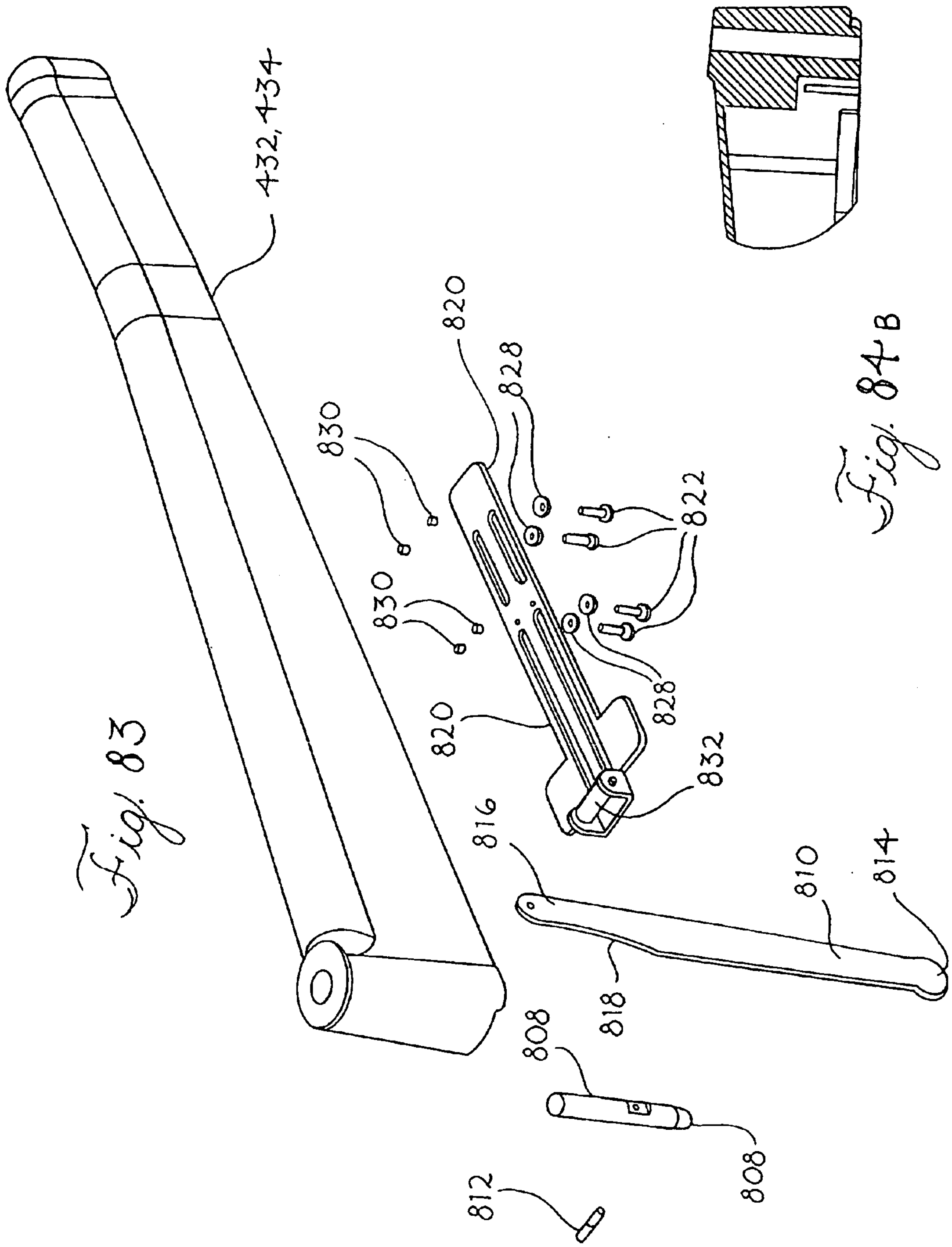

Fig. 83

Fig. 84B

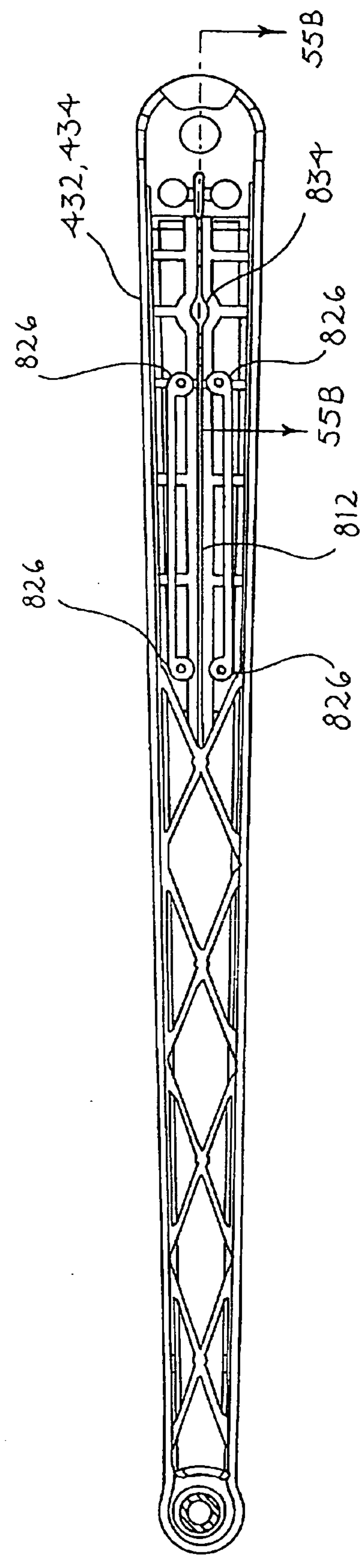

Fig. 84A

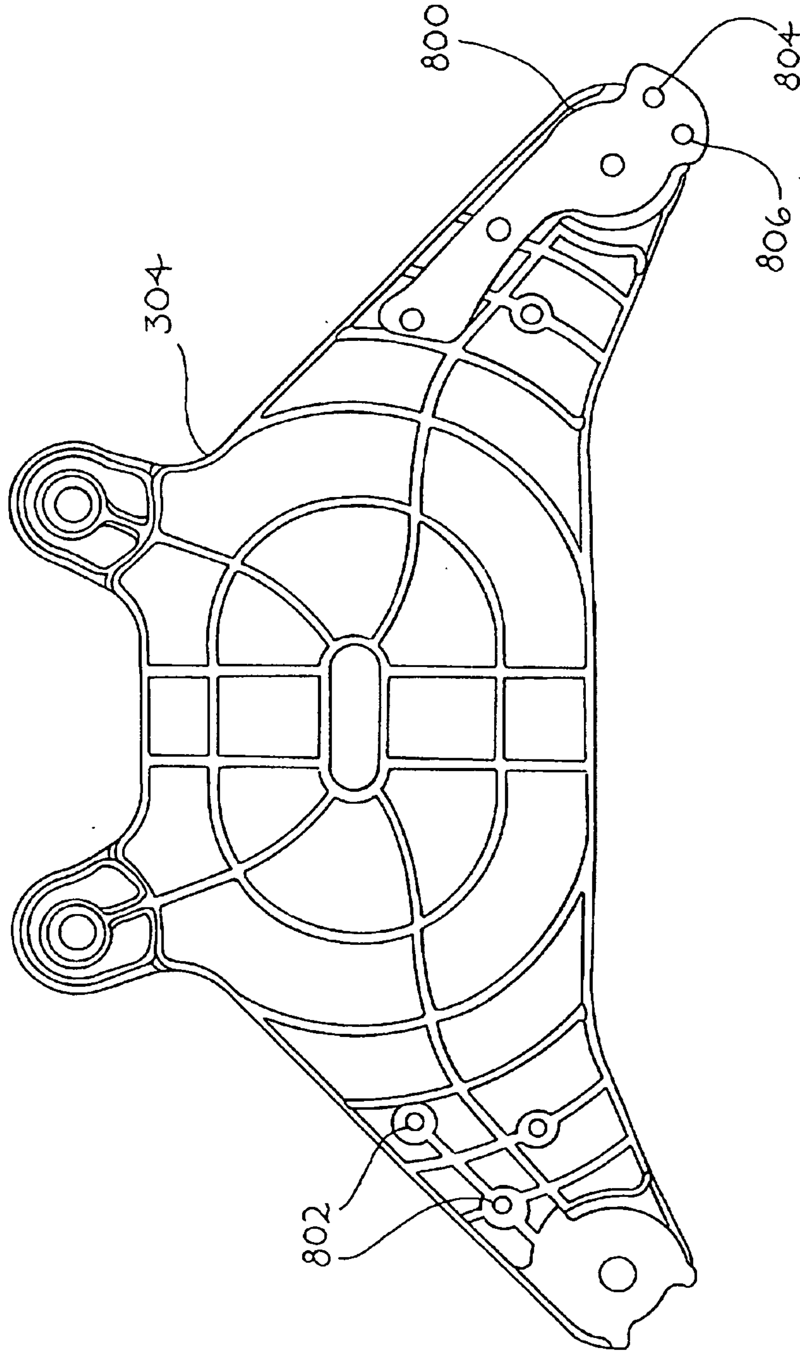

Fig. 85